[redacted]

C69-1884

15880

CLASSIFICATION CHANGE
UNCLASSIFIED
To
By auth
Chang
Cl
Scientific and Technical Infor
ility
12/31/72

SID 62-1060-5

FLIGHT TEST NO. 5
PHASE II, PART A
PARAGLIDER DEVELOPMENT PROGRAM (U)

31 November 1962 19

Prepared by

Paraglider Systems Test

Approved by

A. A. Tischler
Chief Engineer
Paraglider Program

[redacted]

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

FORM M158-D-4 LONGER REV. 2-61

[redacted]

CONFIDENTIAL

FOREWORD

The Space and Information Systems Division (S&ID) of North American Aviation, Inc., and the National Aeronautics and Space Administration, Manned Spacecraft Center (NASA/MSC), Houston, Texas, entered into contract NAS9-167 on 20 November 1961. This contract stipulates that a flight-test report be submitted to the NASA within ten working days of each flight during the flight test program. This is the fifth report of a half-scale, instrumented test vehicle flight; it concluded the predeployed glide test series.

ABSTRACT

The fifth predeployed flight test of the half-scale Paraglider was attempted on 23 October 1962. The data presented shows that this flight test was successful. Satisfactory trim point and test vehicle stability during glide is verified by data analysis.

CONFIDENTIAL

CONTENTS

Section		Page
1.0	INTRODUCTION	1
2.0	FLIGHT OBJECTIVES AND RESULTS	3
3.0	TEST CONFIGURATION	5
4.0	TEST DESCRIPTION	7
	Special Tests	7
	Lakebed Testing	7
	Postflight Inspection	9
	Range Data	11
5.0	EVALUATIONS AND CONCLUSIONS	51
	Flight Performance Evaluation	51
	General	51
	Aerodynamic Performance	51
	Stability And Control	52
	Pitch	52
	Lateral	53
	Instrumentation Systems Evaluation	54
	Flight Control Systems Evaluation	55
	Electrical Power Systems Evaluation	56
	Radio Command System Evaluation	56
6.0	PARAGLIDER PROBLEM STATUS	57

APPENDIXES

A.	INSTRUMENTATION CONFIGURATION	59
B.	MASTER INSTRUMENTATION LIST	61

ILLUSTRATIONS

Figure		Page
1	Half-Scale Paraglider Lift-Off	8
2	Half-Scale Paraglider in Glide Configuration	10
3	Half-Scale Paraglider in Flare Configuration	10
4	Altitude Versus Time From Release	15
5	Rate-of-Descent and Tangent Plane Velocity Versus Time From Release	17
6	Altitude Versus Range North (Y)	19
7	Altitude Versus Range East (X)	21
8	Range North (Y) Versus Range East (X)	23
9	Temperature and Pressure (MB) Weather Data	25
10	Wind Velocity and Direction Weather Data	26
11	Shroud Line Loads Versus Elapsed Time (T=0 to T+150 Seconds)	27
12	Shroud Line Loads Versus Elapsed Time (T+150 to T+264.6 Seconds)	29
13	Shroud Line Load and Lengths Versus Elapsed Time (T=0 to T+150 Seconds)	31
14	Shroud Line Load and Lengths Versus Elapsed Time (T+150 to T+264.6 Seconds)	33
15	Acceleration Versus Elapsed Time (T=0 to T+150 Seconds)	35
16	Acceleration Versus Elapsed Time (T+150 to T+264.6 Seconds)	37
17	Roll, Pitch, and Yaw Rates Versus Elapsed Time (T=0 to T+150 Seconds)	39
18	Roll, Pitch, and Yaw Rates Versus Elapsed Time (T+150 to T+264.6 Seconds)	41
19	Electrical Load, Boom Pressure, and Boom Temperature Versus Elapsed Time (T=0 to T+150 Seconds)	43
20	Electrical Load, Boom Pressure, and Boom Temperature Versus Elapsed Time (T+150 to T+264.6 Seconds)	45
21	Control-Drum Rates Versus Elapsed Time (T=0 to T+150 Seconds)	47
22	Control-Drum Rates Versus Elapsed Time (T+150 to T+264.6 Seconds)	49

CONFIDENTIAL

1.0 INTRODUCTION

The test report describes the fifth half-scale pre-deployed glide test and the results obtained. The flight was conducted over the Rogers Dry Lakebed of Edwards Air Force Base, California, by North American Aviation, Inc., Space and Information Systems Division (NAA/S&ID), in conjunction with the National Aeronautics and Space Administration, Flight Research Center (NASA/FRC). Major test emphasis was to verify satisfactory trim point and test vehicle stability during glide. Test configuration No. 1, as described in "Paraglider Development Test Plan, Phase II, Part A," SID 61-471, "Section A," was used for this flight with a variation in capsule weight.

2.0 TEST OBJECTIVES AND RESULTS

Specific test objectives of Flight Test No. 5 and results obtained are as follows:

1. Obtain data for correlation with analytically determined stability characteristics.

   Results: Accomplished

   On-board data and observed flight characteristics provided adequate data for correlation with analytically determined stability characteristics.

2. Evaluate Paraglider glide stability and range

   Results: Accomplished

   The observed free flight characteristics, as well as the on-board data, indicated no apparent problem areas.

3. Evaluate the landing flare.

   Results: Accomplished

   Adequate data was obtained to evaluate the landing flare and provide information to make the required changes.

4. Verify satisfactory functional operation of the following systems:

   Electrical Power

   Results: Accomplished

   The electrical power system operated satisfactorily during the test.

   Radio Command

   Results: Accomplished

   The radio command system operation was satisfactory throughout the flight and all commands transmitted were received.

Flight Control

Results: Accomplished

The flight control system responded satisfactorily to all commands during the flight.

Instrumentation

Results: Accomplished

All systems operated satisfactorily and useful data was obtained with the exception of measurement P201 (Normal acceleration) which was inoperative through the entire flight.

5. Verify the adequacy of the field-of-view of the on-board data cameras.

Results: Accomplished

The on-board data cameras, No. 1 (Horizon) and No. 3 (Spreader Bar) provided good photographic coverage during the flight and demonstrated the adequacy of the field-of-view. Camera No. 2 (Deployment) was not installed.

3.0 TEST CONFIGURATION

The test configuration used for this flight conforms to Configuration No. 1 shown in Table 1 of SID 61-471, with the exception of a variation in capsule weight. See the weight statement in Table 1 for capsule/ Paraglider configuration weight. Table 2 describes the half-scale capsule and Paraglider center of gravity.

The test vehicle was a complete flight article with the following exceptions:

1. The "A" can was not installed.

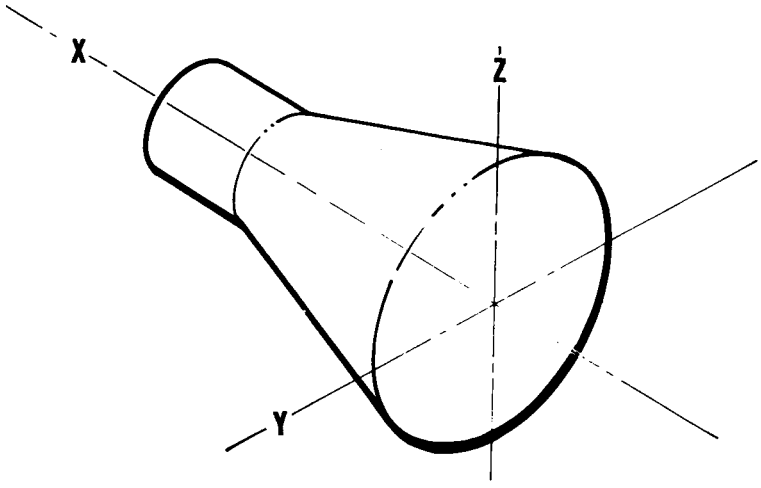
2. The capsule wiring was modified to allow the test vehicle to be released from the tow cable and the tape transport to be turned on by radio command from the Director Aircraft.

3. A special sequencing package was installed for predeployed flight. The channel assignment list and instrumentation list are defined in Appendix A and Appendix B respectively.

Table 1. Weight Statement for
Half-Scale Capsule/Paraglider Configuration

Item	Weight (Lbs)
Capsule	811.0
Wing	90.0
Control Cables	2.0
Flare Computer	10.2
Flight Control Cable	0.4
TOTAL	913.6

Table 2. Half-Scale Capsule/Paraglider Centers of Gravity



Axis	Glide	Flare
Horizontal (X)	14.43	9.73
Lateral (Y)	0	0
Vertical (Z)	6.67	6.26

4.0 TEST DESCRIPTION

The flight test plan provided for a flight consisting of towing the test vehicle to 8,000 feet pressure altitude with the H-37B helicopter, releasing the test vehicle from the tow cable by a radio-command signal from the airborne controller in the T-37B Director Aircraft, and a radio-controlled glide to a flared landing.

SPECIAL TESTS

In preparation for the flight test, three special tests were performed in addition to two satisfactory simulated flights with the test vehicle installed in combined systems test stand. A special test with the half-scale test vehicle in flight configuration and match squibs was performed on internal battery power. The second special test was conducted with the half-scale test vehicle and live squibs (full flight configuration) on internal battery power and special instrumentation to record the electrical loads during the squib firings. The third special test was of the Radio Command System on internal battery power, to determine the operating limits of the radio-command transmitter-receiver system. All three special tests were satisfactory. Following the special radio command check, two satisfactory simulated flights were performed and the capsule was closed out for flight.

LAKEBED TESTING

On the morning of the flight test, the test vehicle was transported to the lift-off area on the lakebed and positioned in the lift-off pad. The squib installation was made just prior to the attachment of the wing. Following satisfactory completion of all the other ground checks, satisfactory radio-command checks were made with both the ground control vehicle and the T-37B Director Aircraft.

The lift-off (Figure 1) from the lakebed occurred at 0806 PDT and was satisfactory. During the initial portion of the towed flight the capsule was oscillating an estimated 90 degrees about the roll axis. The helicopter forward speed was reduced from approximately 28 knots indicated air speed (KIAS) to 24 KIAS and the oscillations reduced greatly. The tow flight continued to the launch point without further incident. Tow release was commanded by the airborne controller at 0825 PDT and release was satisfactorily accomplished.

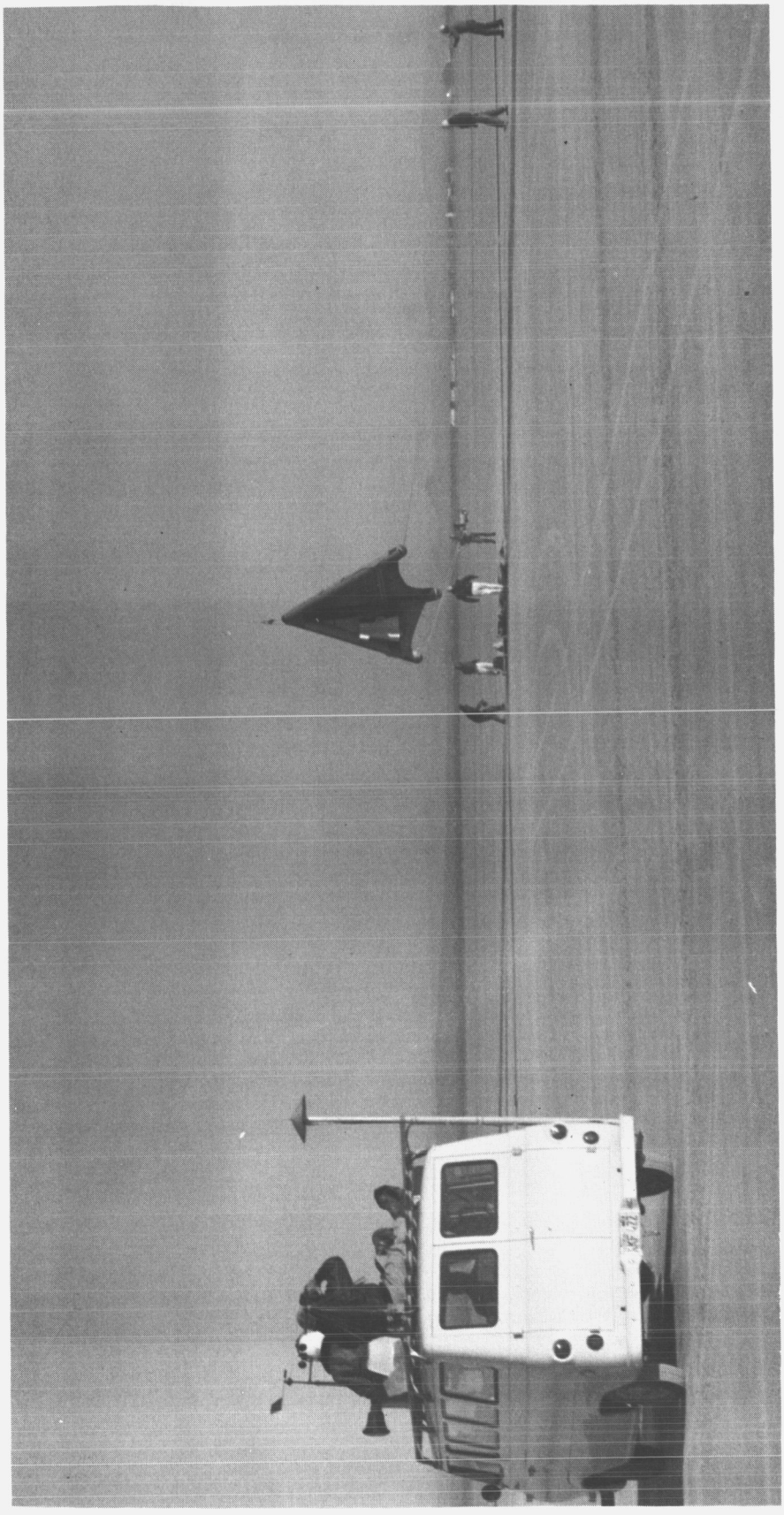


Figure 1. Half-Scale Paraglider Lift-Off

Immediately after release the capsule assumed a very slight left turn. The airborne controller was able to maintain a westerly heading with occasional right turns. Two pitch-down commands were transmitted, and two pitch-up commands were transmitted for return to the glide attitude. Before transfer of radio-command control one pitch-down command was transmitted. It appeared to the airborne controller that this was a more stable nominal glide attitude.

The ground controller assumed control at approximately 2,000 feet above the ground (Figure 2). From 2,000 feet to approximately 800 feet above the ground, the ground controller transmitted several right turns and one left turn to verify control and stability. All commands transmitted resulted in satisfactory response throughout the flight.

At approximately 800 feet above the ground, another pitch-down command (total of two) was transmitted to effect a preflare maneuver. A definite change in pitch attitude was observed by the ground controller. At 50 feet above the ground, the flare maneuver (Figure 3) was initiated with a very noticeable decrease in the rate-of-descent and forward speed. Approximately one-half second later two pitch-up commands were transmitted to complete the flare maneuver. At landing the two aft shoes appeared to touch when the forward shoe was approximately one foot from the ground. Paint marks on the lake bed indicated that the aft shoes skidded approximately one foot before the forward shoe made contact. The forward shoe remained at the point of contact and sheared off while the capsule tumbled forward approximately 10 to 15 feet high and 50 feet forward. The capsule came to a stop upside down on the right trailing edge of the sail. Total flight time, as recorded by radar, was four minutes and twenty four and six tenth seconds.

POSTFLIGHT INSPECTION

Preliminary visual inspection on the lakebed revealed three minor tears in the right aft portion of the wing sail. These were contained to a small area no greater than one square foot and were apparently caused by the capsule tumbling after touchdown. Capsule damage was limited to a dented aft fairing in the vicinity of the drogue mortar canister. Table 3 presents the sequence of events during lakebed operations.

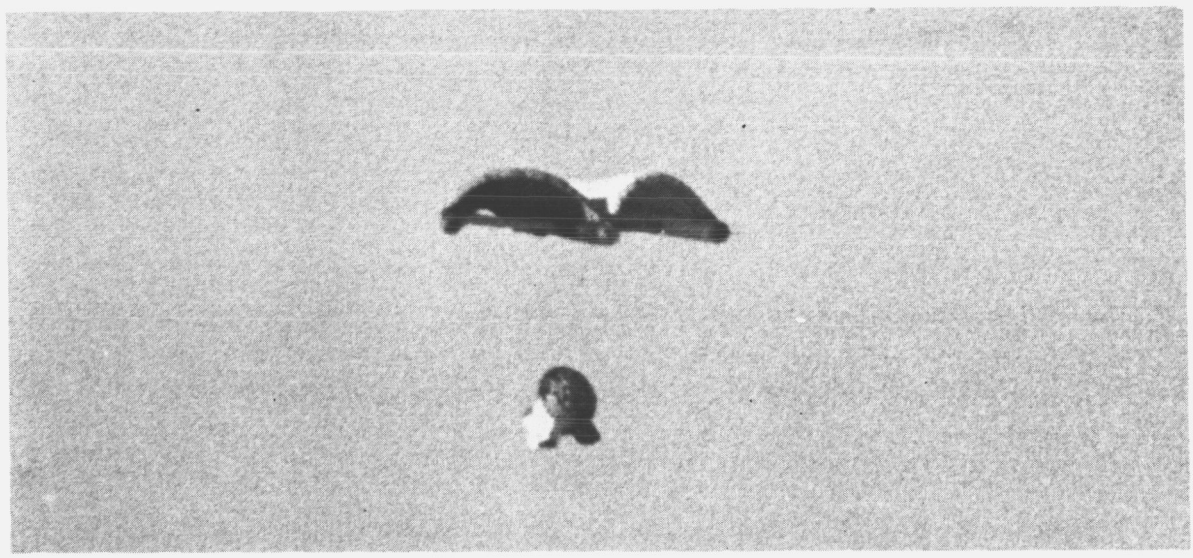


Figure 2. Half-Scale Paraglider in Glide Configuration

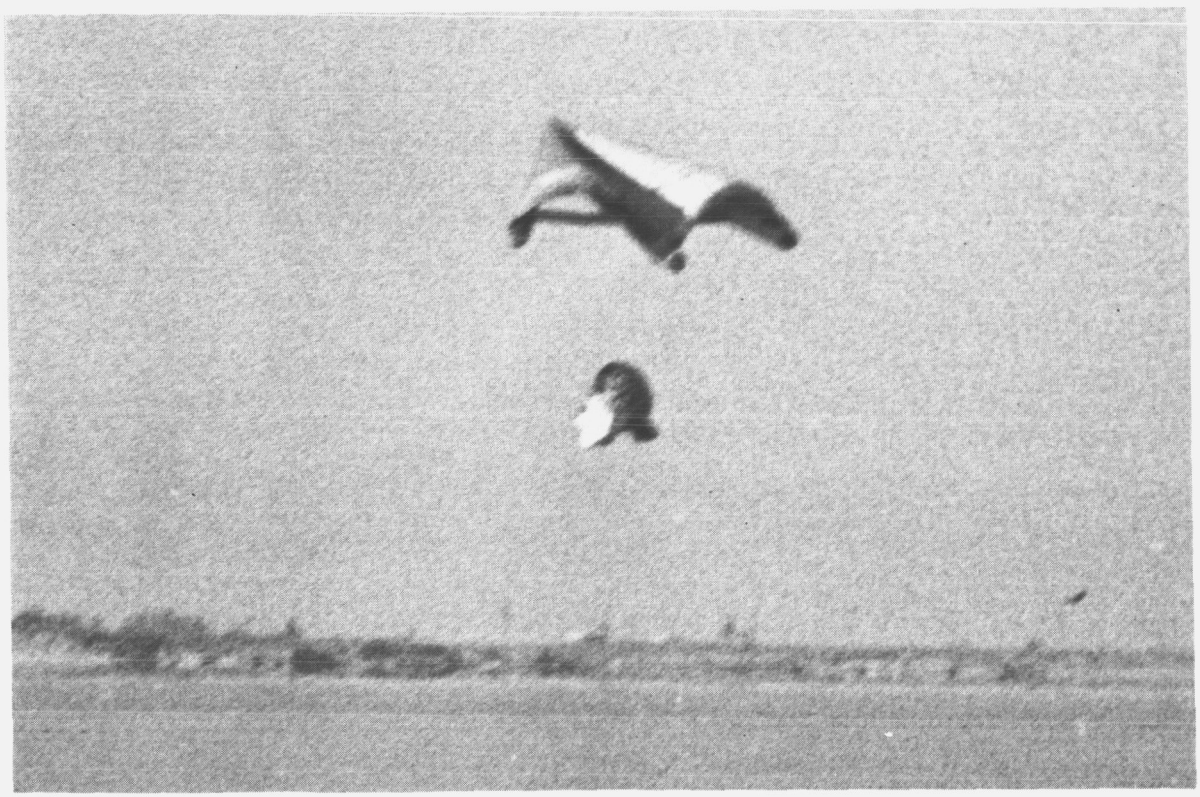


Figure 3. Half-Scale Paraglider in Flare Configuration

Table 3. Lakebed Operation Sequence of Events

EVENT	TIME (PDT)
Lakebed Operations Started	0430
Test Vehicle Lift-off	0806
Release	0825
Test Vehicle Touchdown	0829.4

RANGE DATA

Figures 4 through 10 are derived from data gathered by range personnel.

Figures 4 and 5 present altitude, rate-of-descent, and tangent plane velocity (velocity over the ground) versus elapsed time.

Figures 6, 7 and 8 show a three-view representation of the actual glide trajectory.

Figures 9 and 10 represent weather conditions existing in the test area during the flight.

These data indicate that release occurred at an altitude of 8520 feet above sea level. Capsule touchdown was on the lake bed at an altitude of 2270 feet. The flight proceeded in a generally westerly direction on an average heading of about 250 degrees. Total distance covered over the ground was approximately 17,080 feet. Total flight time was 264.4 seconds.

The wing pressure just prior to lift-off was 11.8 psig. The wing pressure was 11.2 psig a few minutes after the flight.

The preflight and postflight battery voltages were as follows:

Battery	Preflight	Postflight
Main Power	41.2	41.75
TAP (Main Power)	34.0	23.5
Instrumentation	33.8	33.8
Flight Control	±20.8	±18.0

The data presented on Figures 11 thru 22 are derived from the on-board magnetic tape recording of the flight test. All measurements operated properly with the exception of Normal Acceleration (P201), which was inoperative during the entire flight. Data were obtained from 8.2 seconds prior to release to 265.4 seconds after release. Touchdown occurred at 264.4 seconds after release.

Due to a relatively high noise content in the commutated wavetrain (about 5 percent of full scale) these data were faired to a degree of smoothness which may not reflect the true characteristics of certain parameters, especially line load measurements. Attempts to describe each excursion of a parameter accurately by reading each commutation segment will result in an accuracy of not better than 5 percent of full scale for any individual reading. Faired data should exhibit greater accuracy for trend information but may deviate from true values by at least 5 percent of full scale for any individual reading. During areas of extreme changes, such as release and impact, individual commutation segments were read to describe peak parameter values. Parameters during periods of lesser activity, such as during stabilized glide, were faired to smooth curves. It should, therefore, be apparent that peak values can be no more accurate than the 5 percent due to the reasons described above.

Certain events during the test were noted from the on-board data. A chronology of these events is presented in Table 4.

Proper response to all radio command functions was indicated. The diagonal and Aft Keel Line Length measurements indicate that two pitch-down commands were entered prior to flare. Two pitch-up commands immediately following the flare command returned the pitch lines to neutral.

The key personnel and their assignment for this test are presented in Table 5.

Table 4. Chronology of Test Events

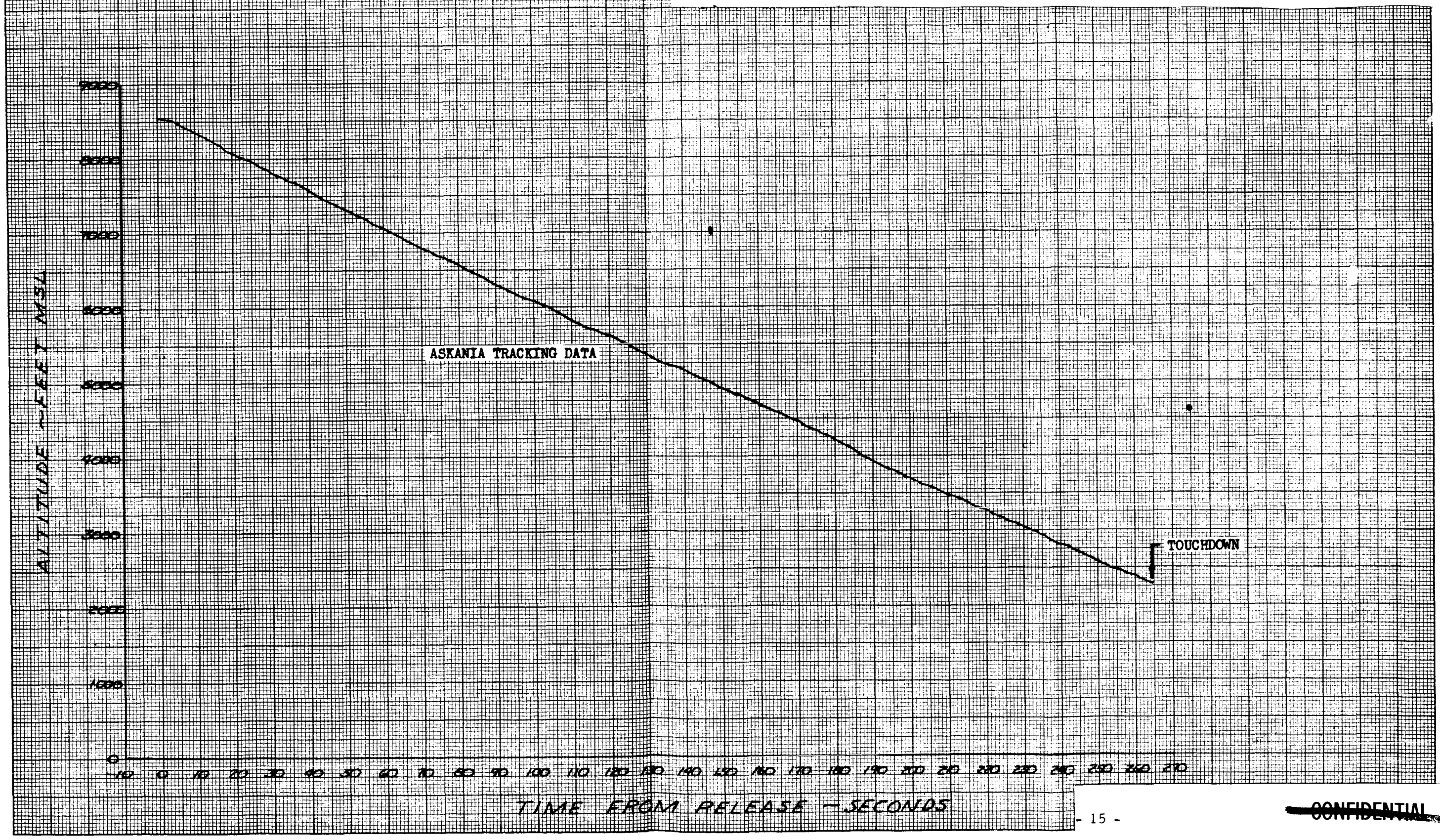
Event	Duration (seconds)	Time from Release (seconds)
Tape Recorder On		-8.2
F/C Pin Release		0
R/C Right Turn	(1.8)	12.5
R/C Left Turn	(0.7)	16.9
R/C Pitch Down	(0.8)	27.7
R/C Pitch Down	(1.1)	37.6
R/C Right Turn	(1.7)	48.4
R/C Right Turn	(2.8)	60.7
R/C Right Turn	(1.2)	67.5
R/C Right Turn	(1.3)	77.5
R/C Pitch Up	(1.1)	95.0
R/C Pitch Up	(1.1)	96.6
R/C Pitch Down	(0.8)	100.9
R/C Right Turn	(1.7)	104.0
R/C Right Turn	(1.7)	125.6
R/C Right Turn	(1.7)	167.5
R/C Left Turn	(1.4)	177.3
R/C Right Turn	(2.0)	185.5
R/C Right Turn	(1.0)	221.2
R/C Pitch Down	(0.8)	235.3
R/C Right Turn	(0.7)	242.0
R/C Flare	(2.7)	261.2
R/C Pitch Up	(0.7)	262.3
R/C Pitch Up	(0.4)	263.2
Touchdown		264.6
Start Invalid Data		265.4

Table 5. Key Test Personnel and Duties

Portion and Organizations	Location	Function	Name
Test Director (NASA/FRC)	Tow Aircraft	Verification of Test Procedures	G. Layton
Test Conductor (S&ID)	Ground Control Van	Overall Supervision of Test	E. Woo
Launch Engineer (S&ID)	Tow Aircraft	Observes Test Vehicle During Test	H. Roper
Airborne Controller (S&ID)	T-37B Director Aircraft	Radio Command Release and Assume Control	R. Saunders
Ground Controller (S&ID)	Ground Control Van	Assumes Control for landing	E. Woo
Range Coordinator (NASA/FRC)	Ground Control Van	Coordinate Support Activities	T. Larsen

~~CONFIDENTIAL~~

Figure 4. Altitude Versus Time From Release



~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

Figure 5. Rate-of-Descent and Tangent Plane Velocity Versus Time From Release

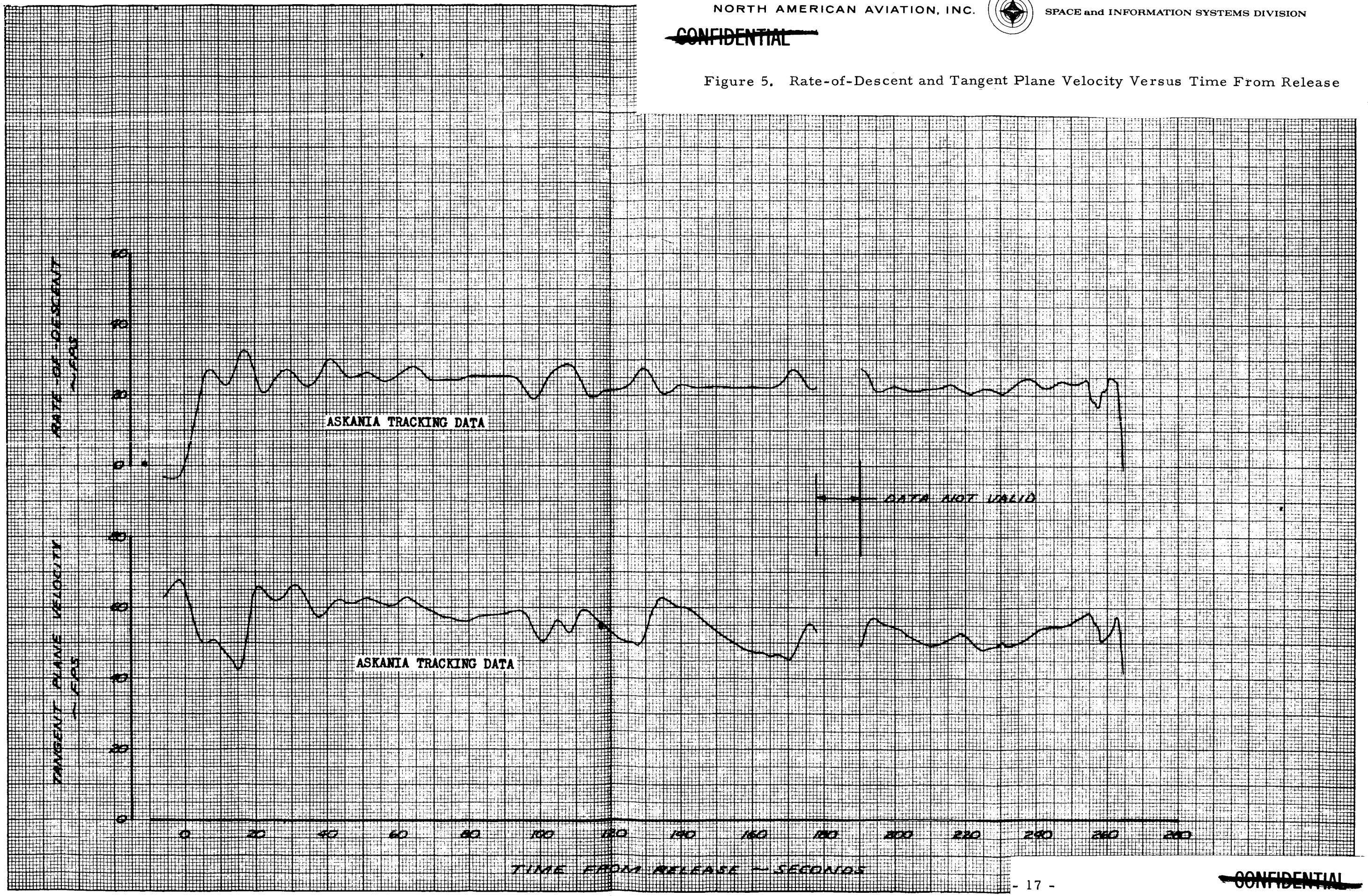


Figure 6. Altitude Versus Range North (Y)

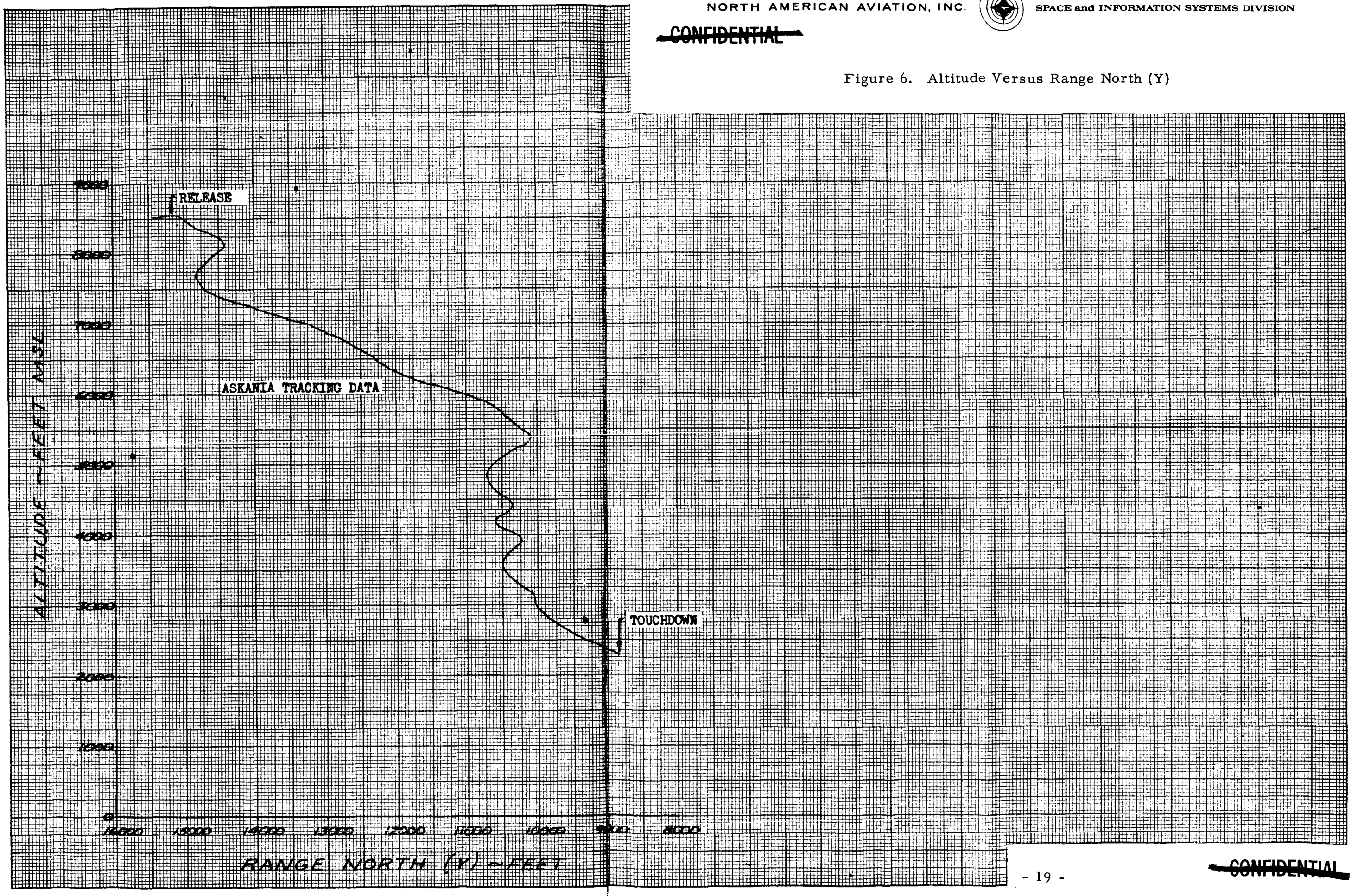


Figure 7. Altitude Versus Range East (X)

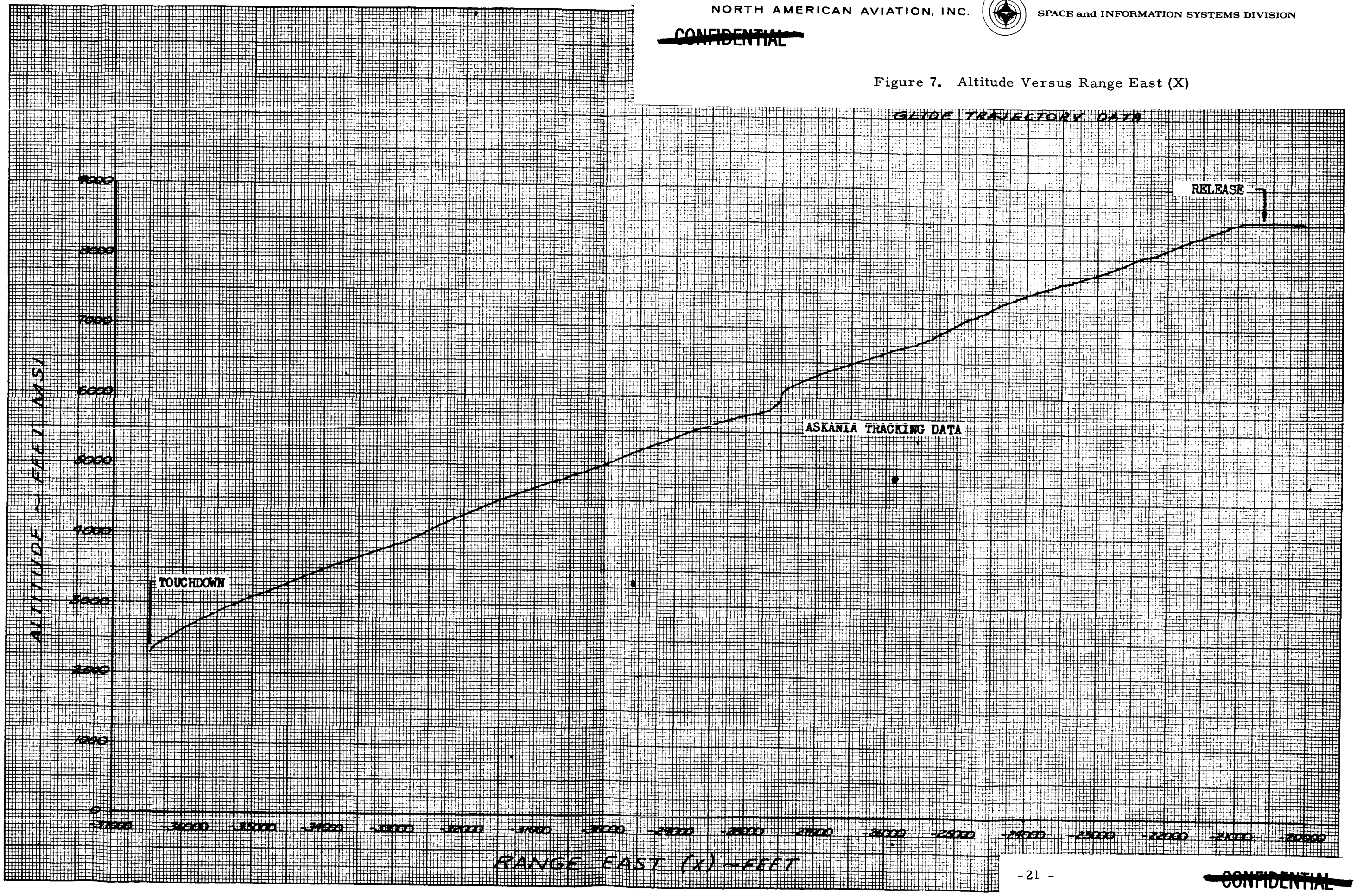
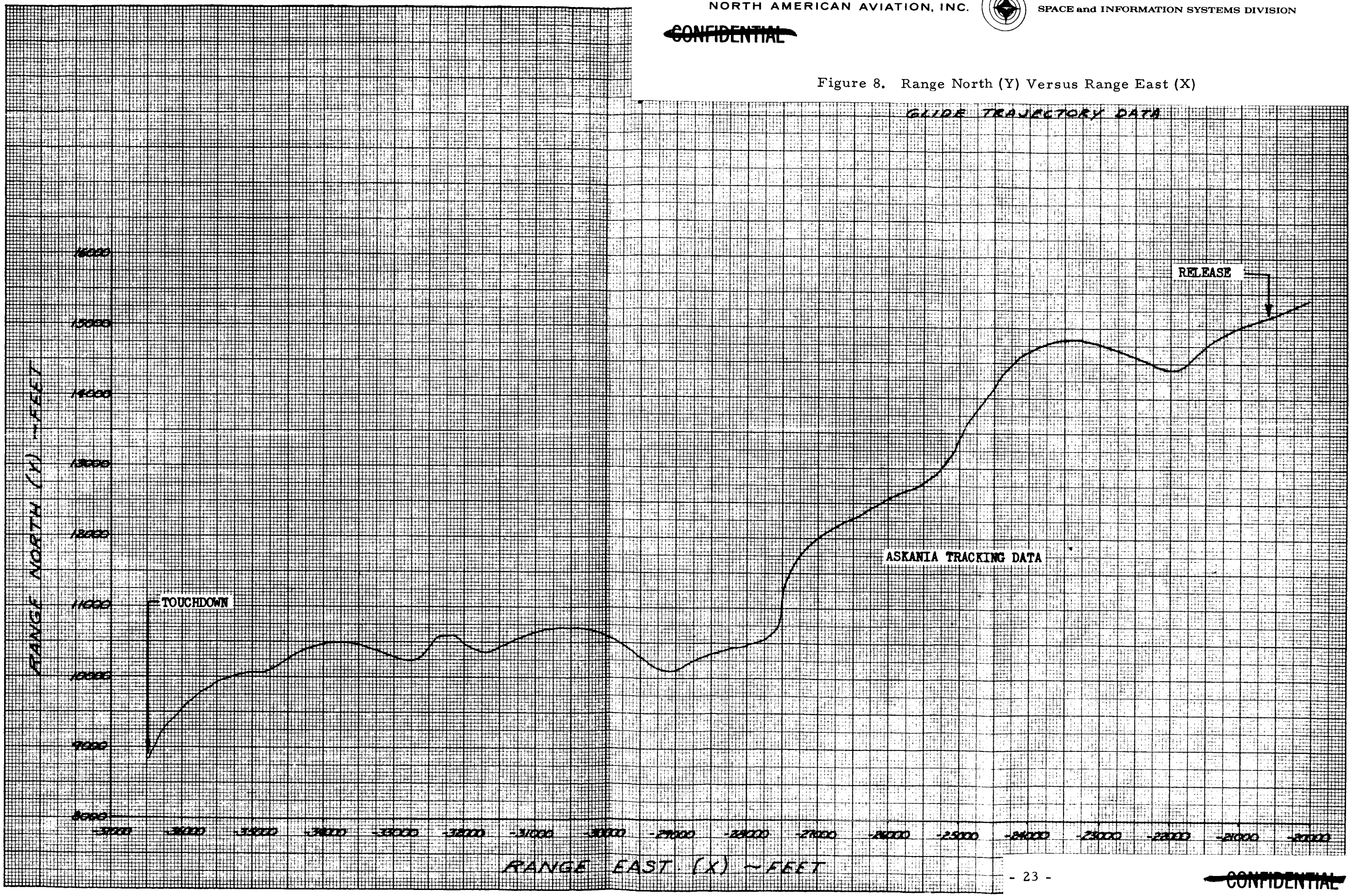
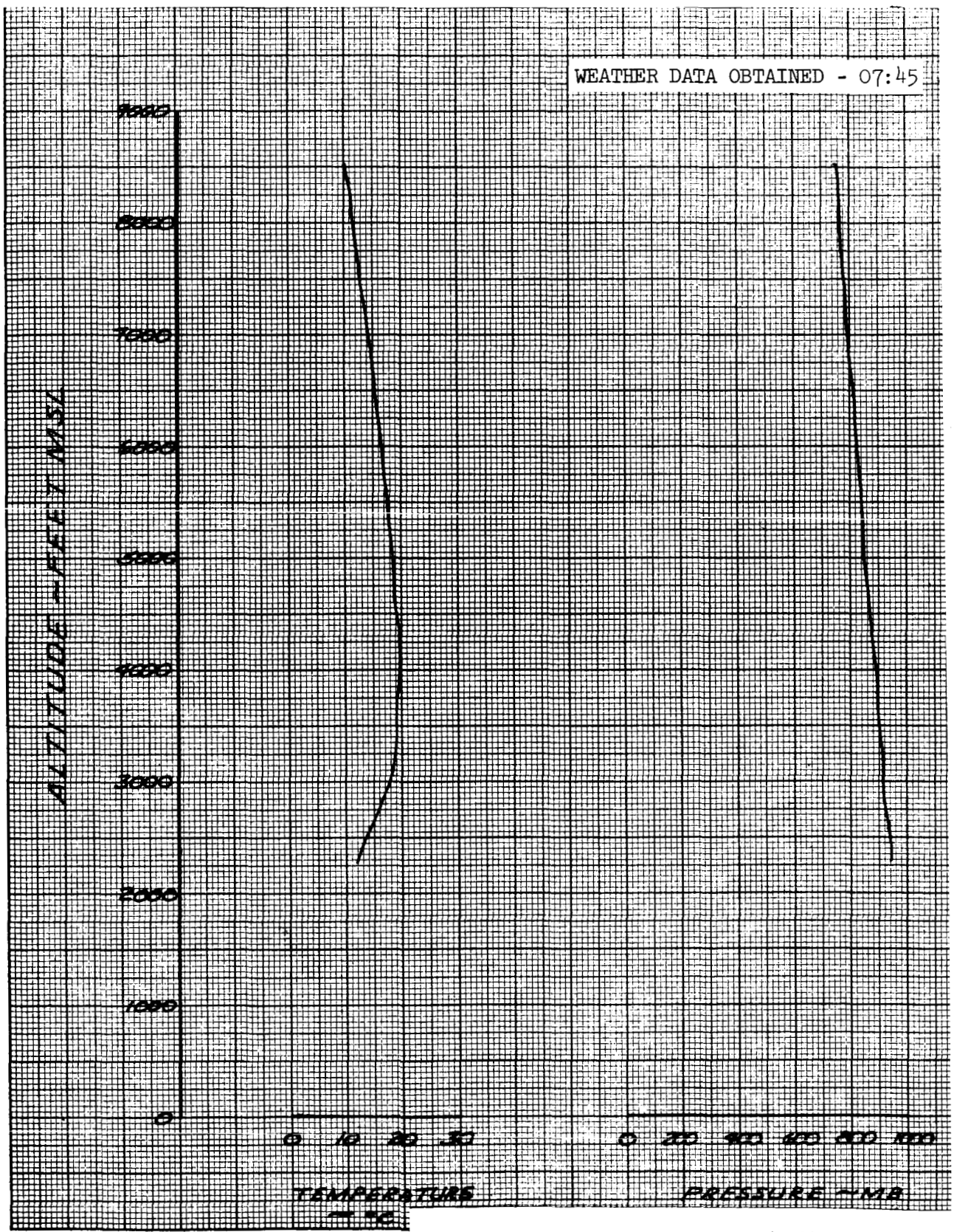


Figure 8. Range North (Y) Versus Range East (X)



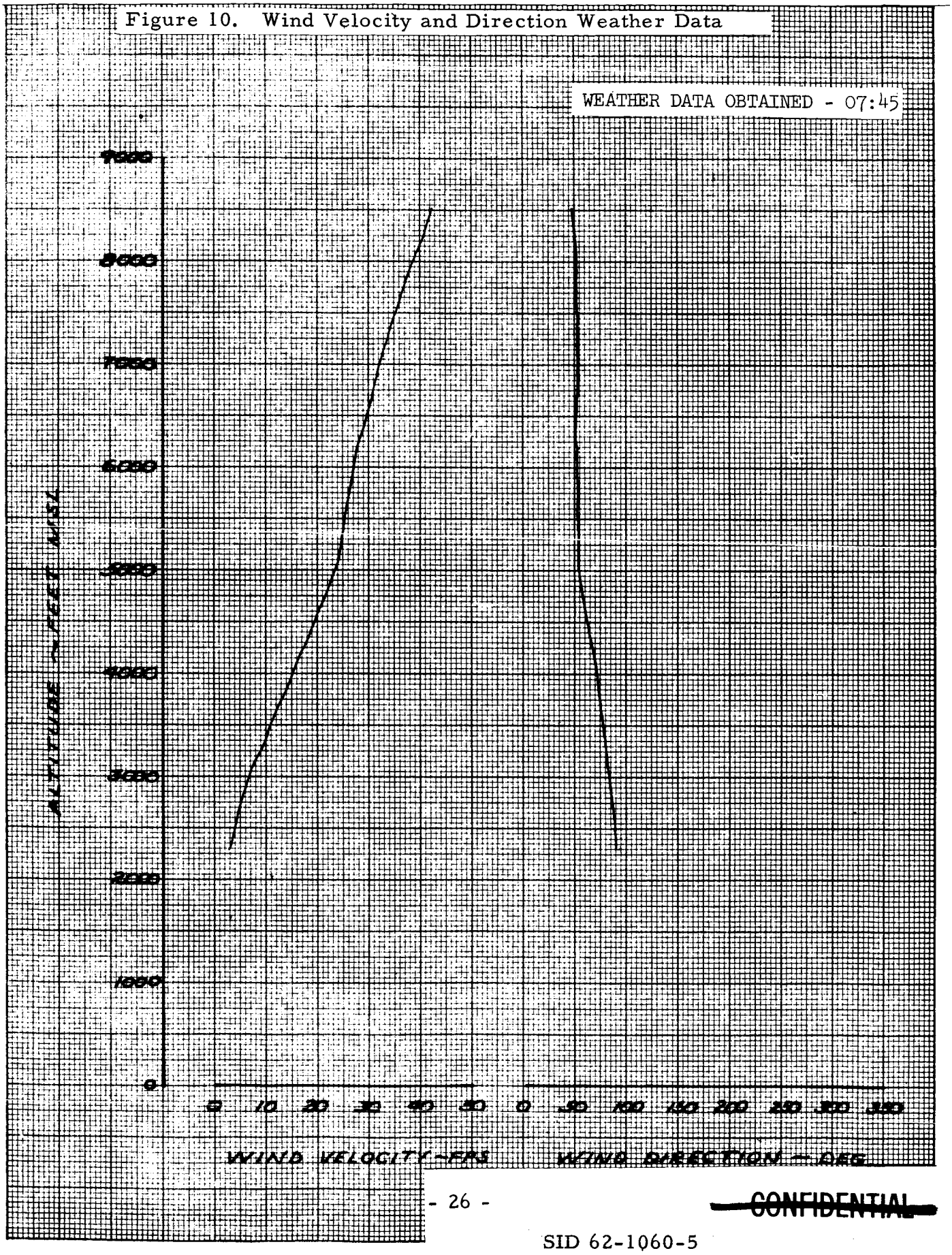
CONFIDENTIAL

Figure 9. Temperature and Pressure (MB) Weather Data



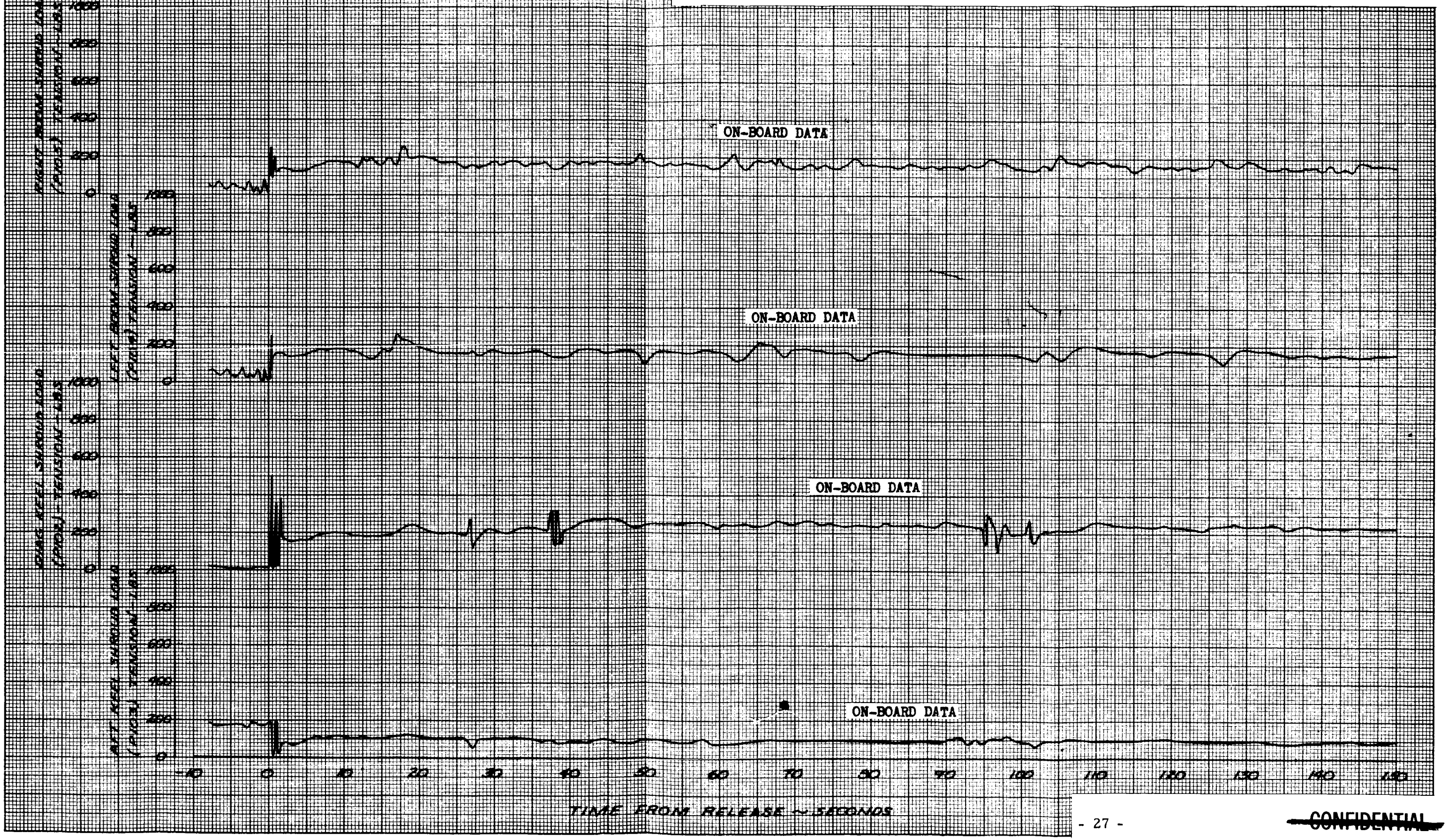
CONFIDENTIAL

Figure 10. Wind Velocity and Direction Weather Data



~~CONFIDENTIAL~~

Figure 11. Shroud Line Loads Versus Elapsed Time (T=0 to T+150 Seconds)



~~CONFIDENTIAL~~

Figure 12. Shroud Line Loads Versus Elapsed Time (T+150 to T+264.6 Seconds)

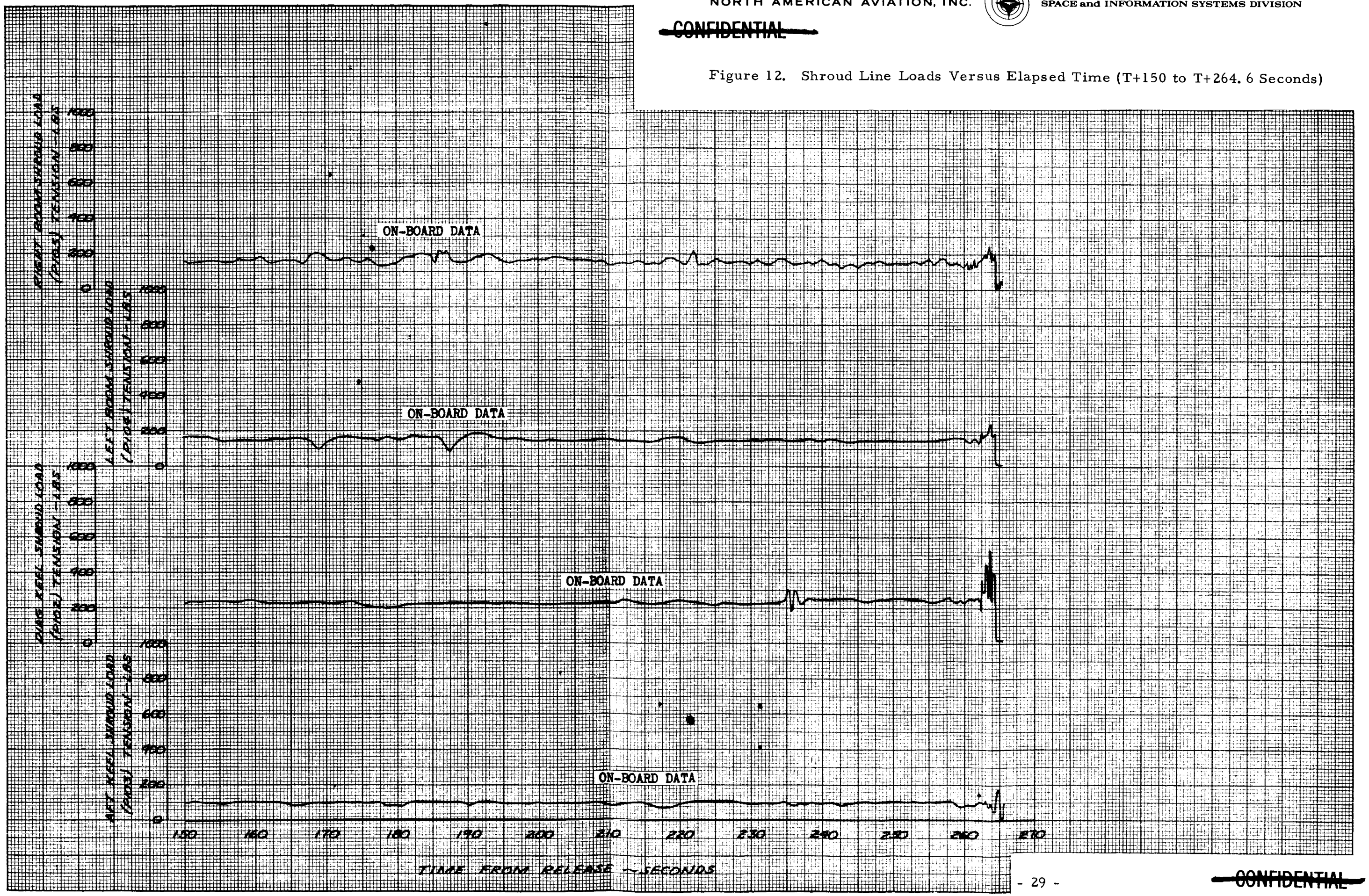
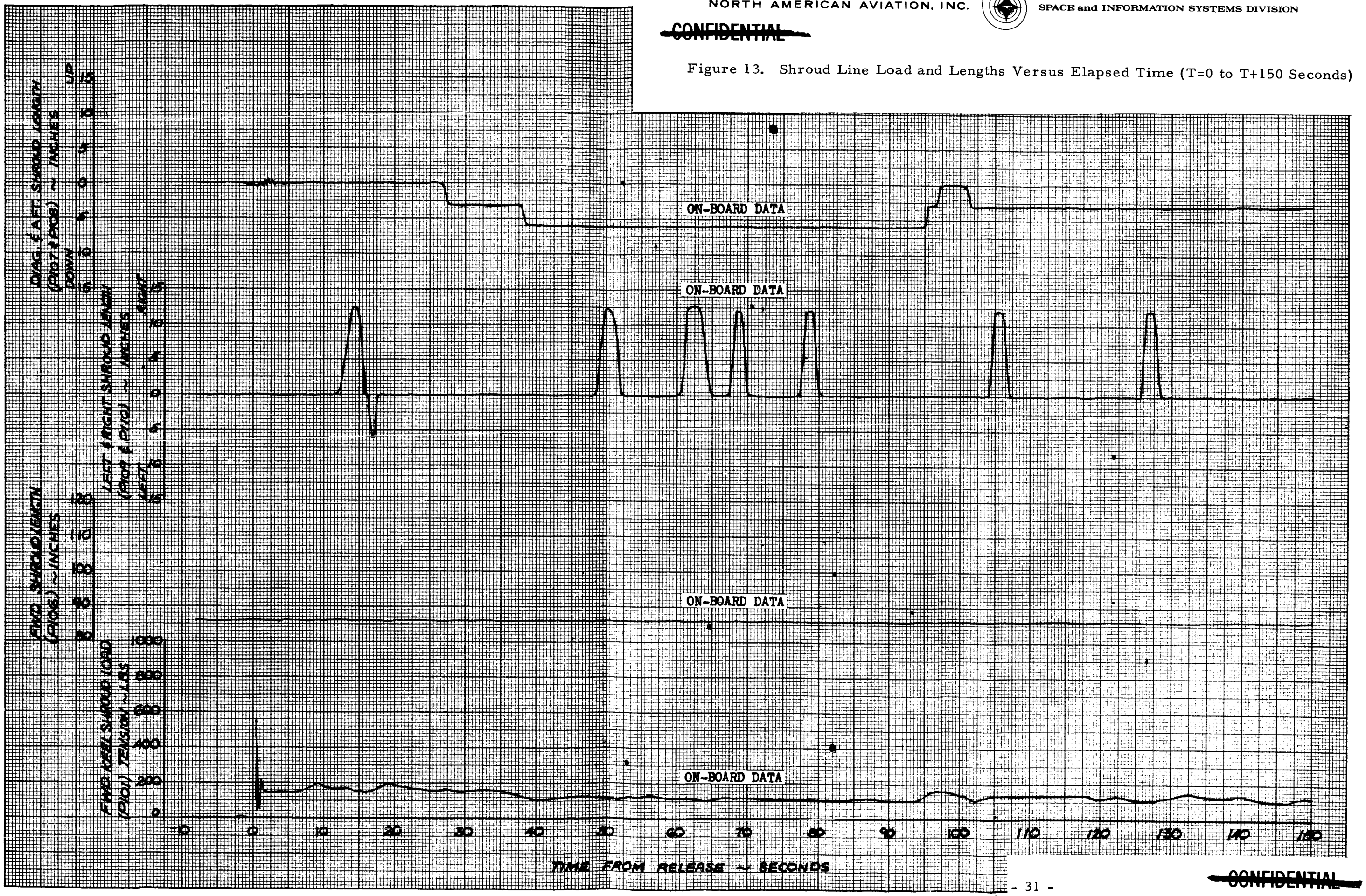
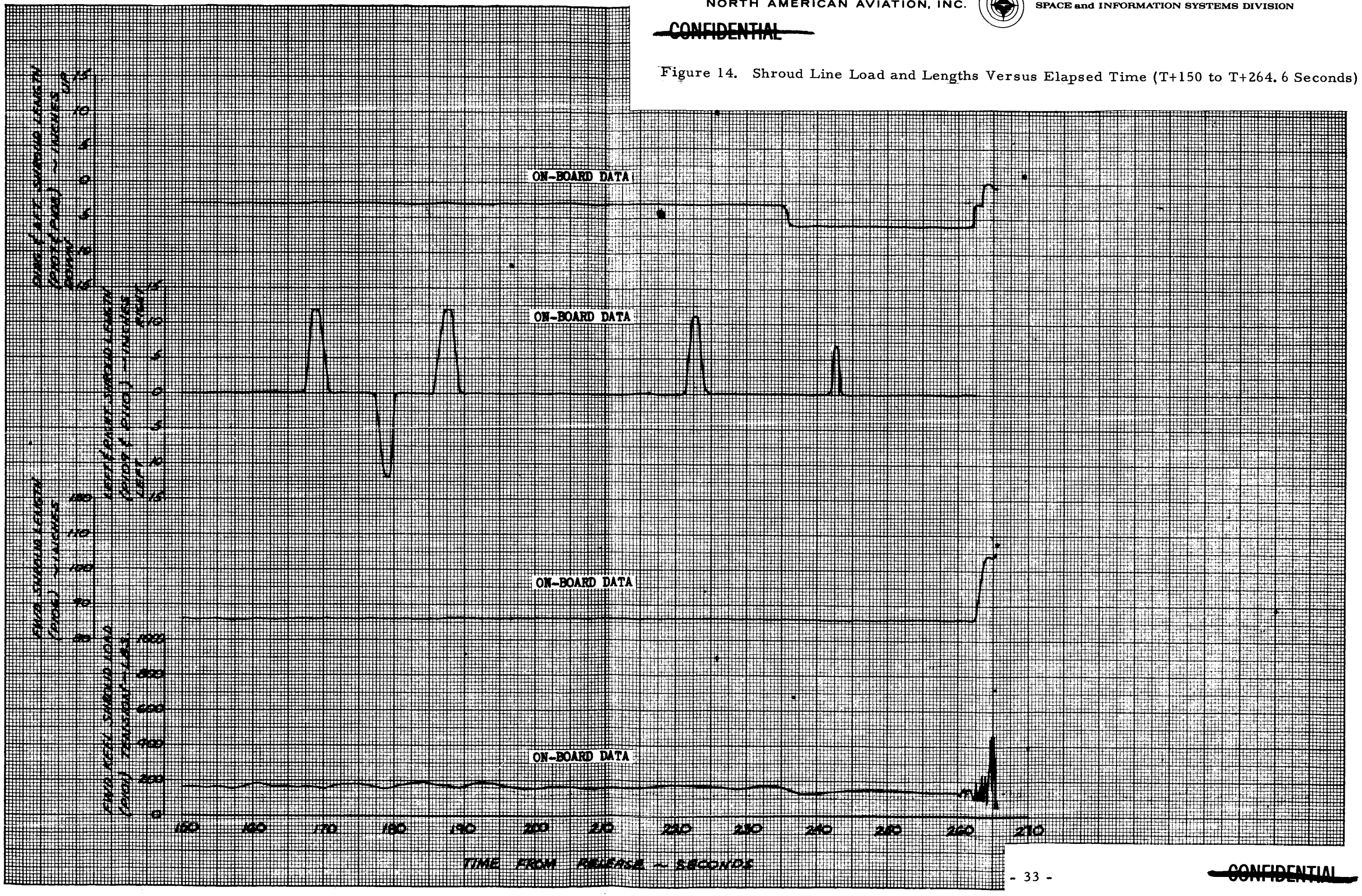


Figure 13. Shroud Line Load and Lengths Versus Elapsed Time (T=0 to T+150 Seconds)



CONFIDENTIAL

Figure 14. Shroud Line Load and Lengths Versus Elapsed Time (T+150 to T+264.6 Seconds)



CONFIDENTIAL

Figure 15. Acceleration Versus Elapsed Time (T=0 to T+150 Seconds)

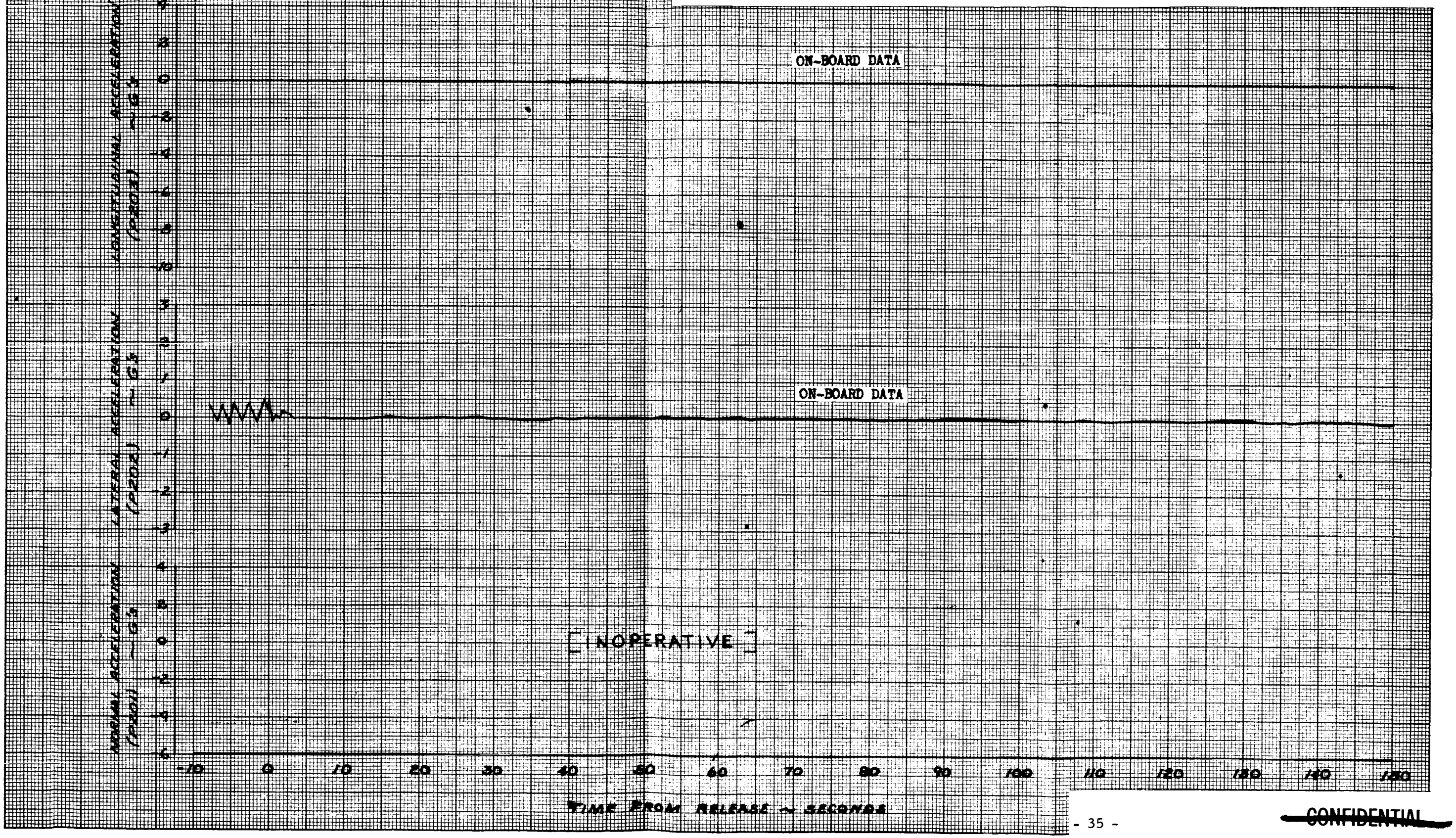
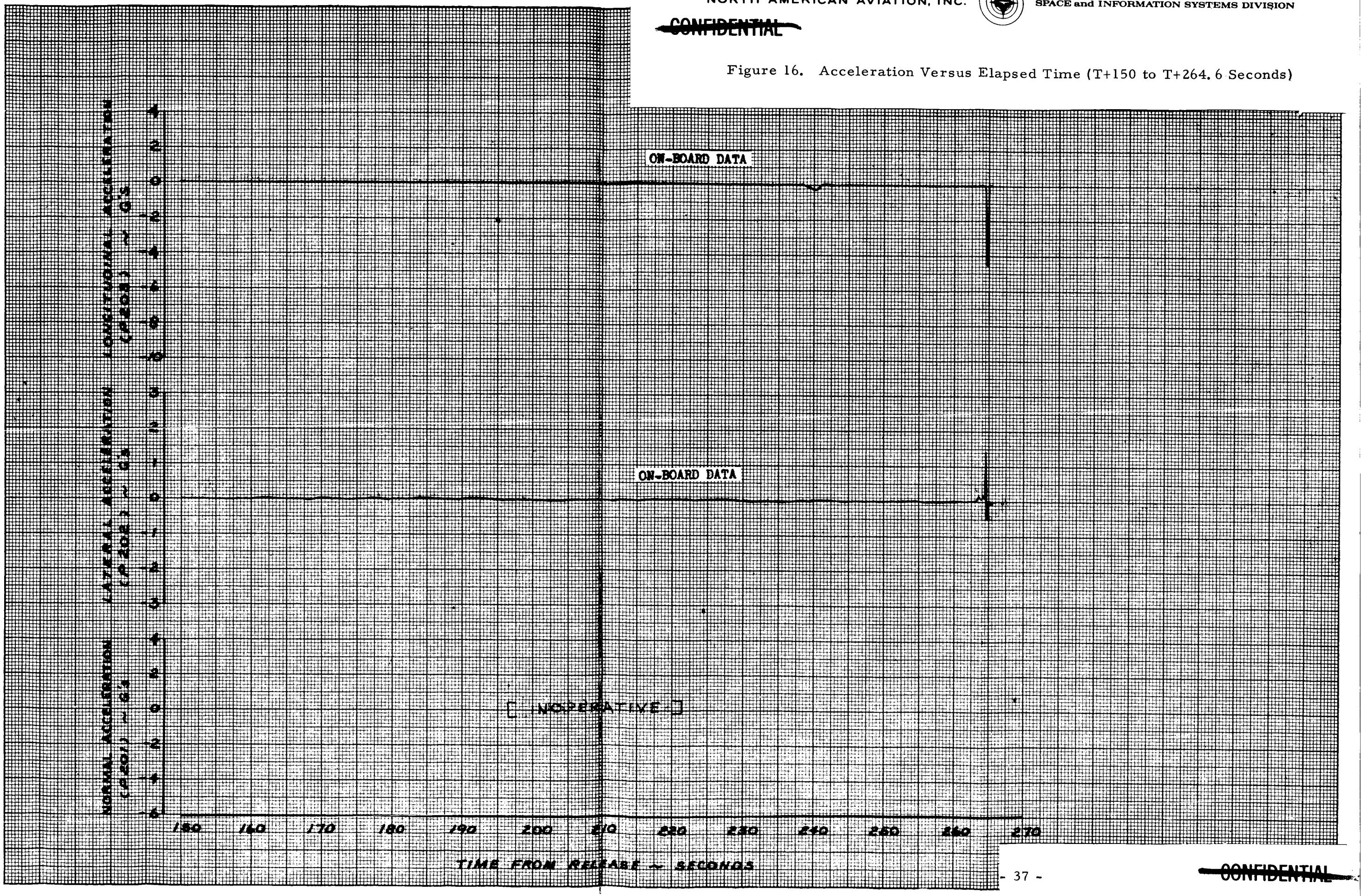
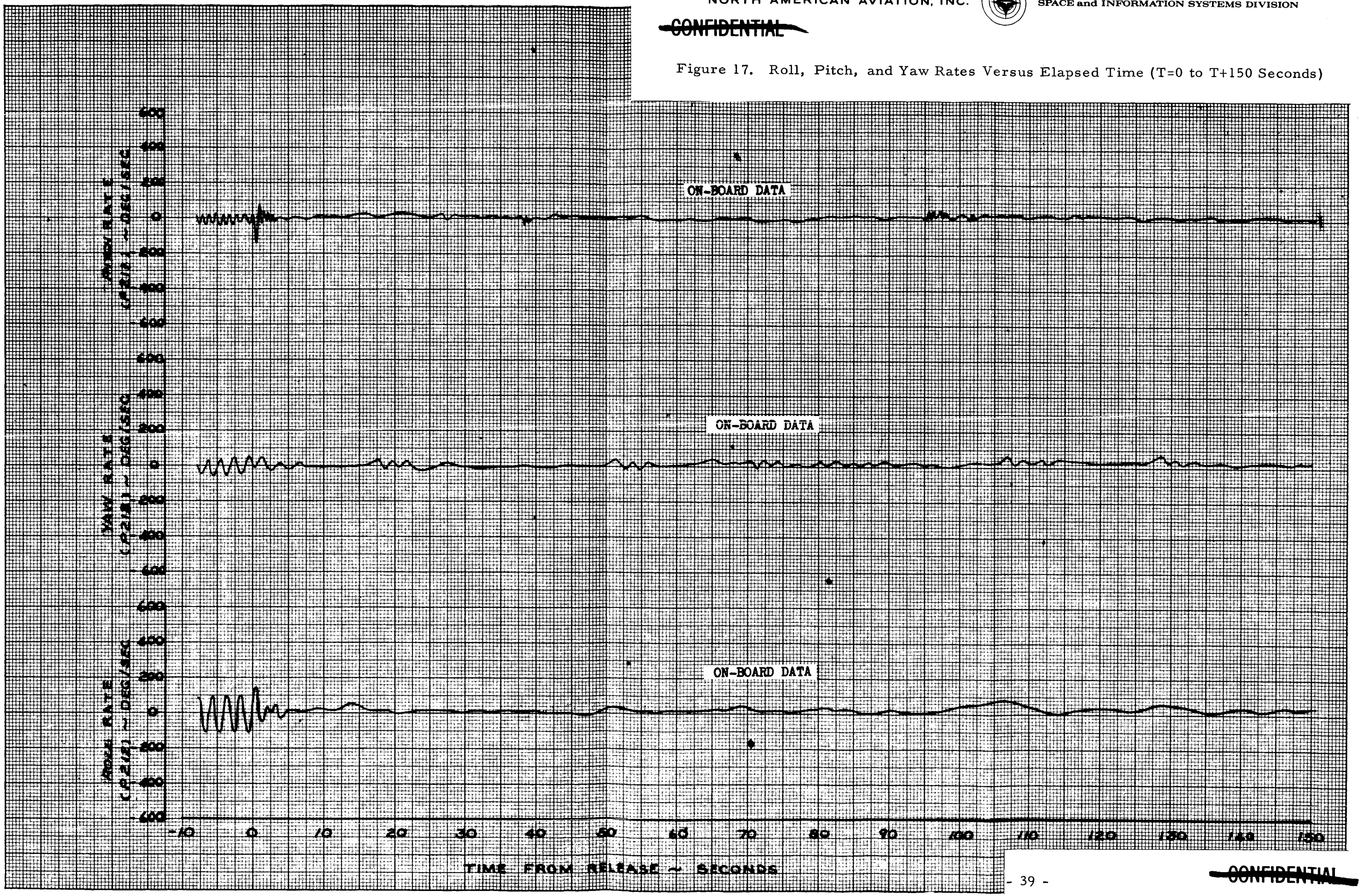


Figure 16. Acceleration Versus Elapsed Time (T+150 to T+264.6 Seconds)



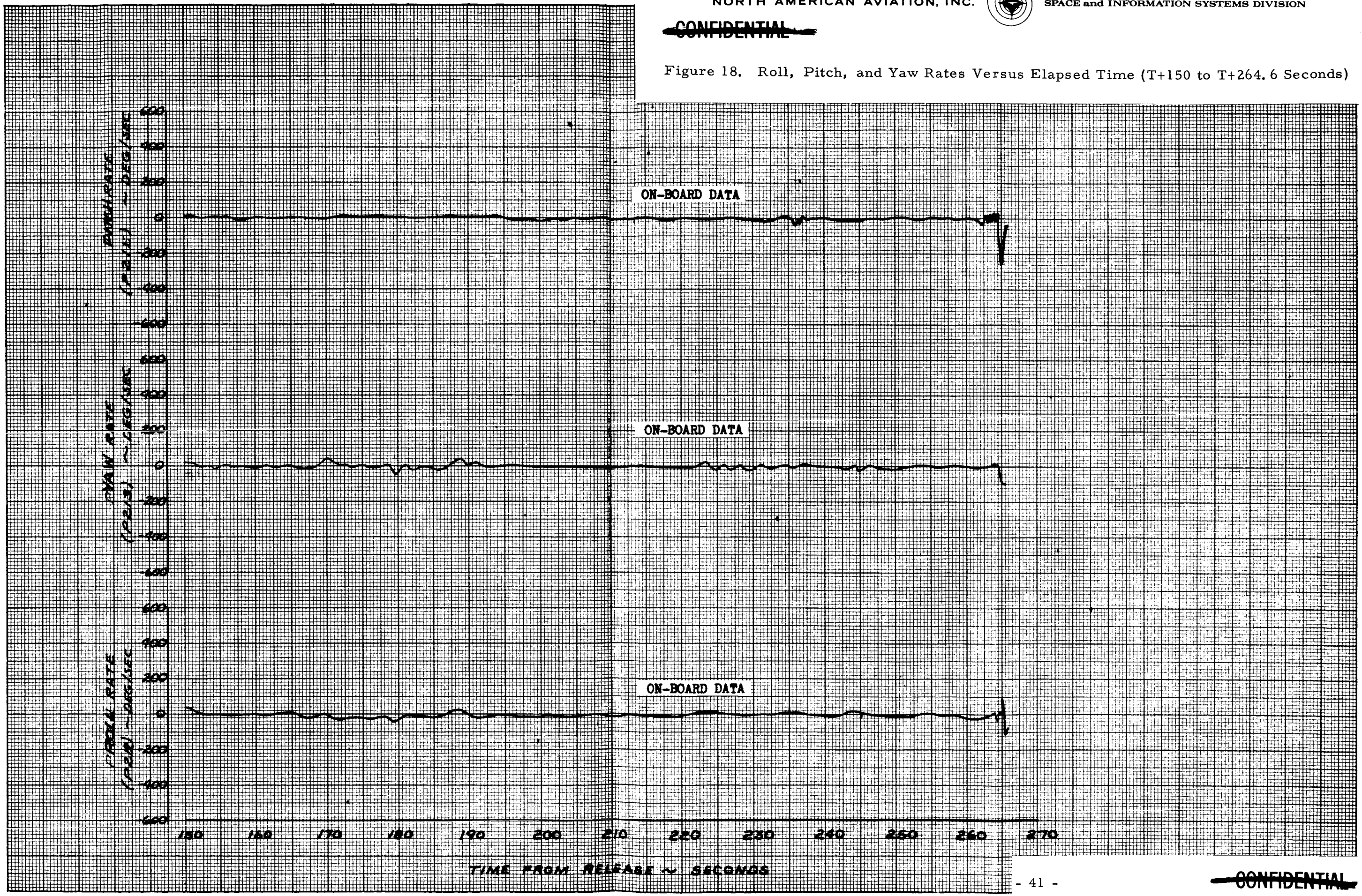
~~CONFIDENTIAL~~

Figure 17. Roll, Pitch, and Yaw Rates Versus Elapsed Time (T=0 to T+150 Seconds)



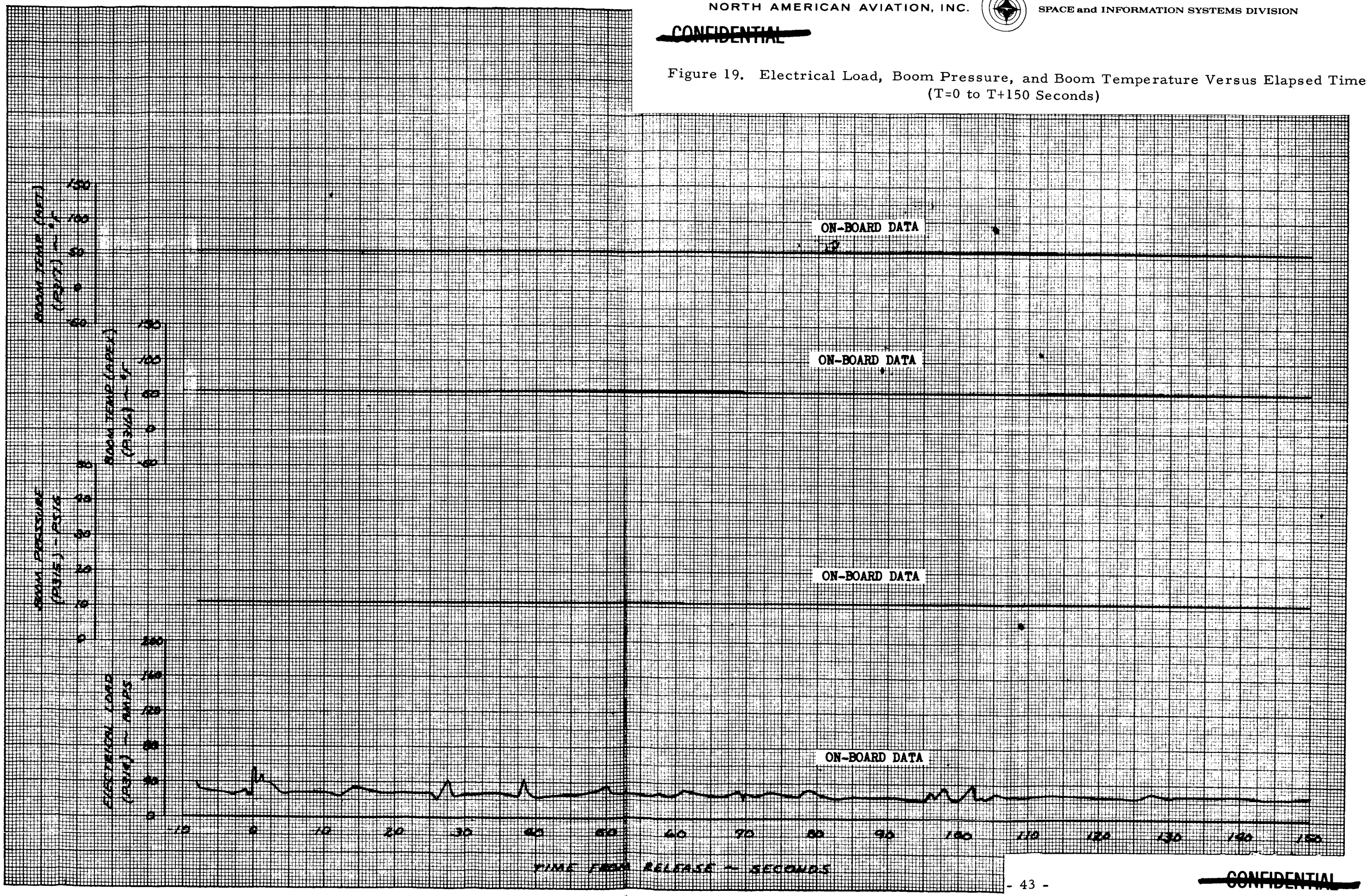
~~CONFIDENTIAL~~

Figure 18. Roll, Pitch, and Yaw Rates Versus Elapsed Time (T+150 to T+264.6 Seconds)



CONFIDENTIAL

Figure 19. Electrical Load, Boom Pressure, and Boom Temperature Versus Elapsed Time (T=0 to T+150 Seconds)



CONFIDENTIAL

Figure 20. Electrical Load, Boom Pressure, and Boom Temperature Versus Elapsed Time (T+150 to T+264.6 Seconds)

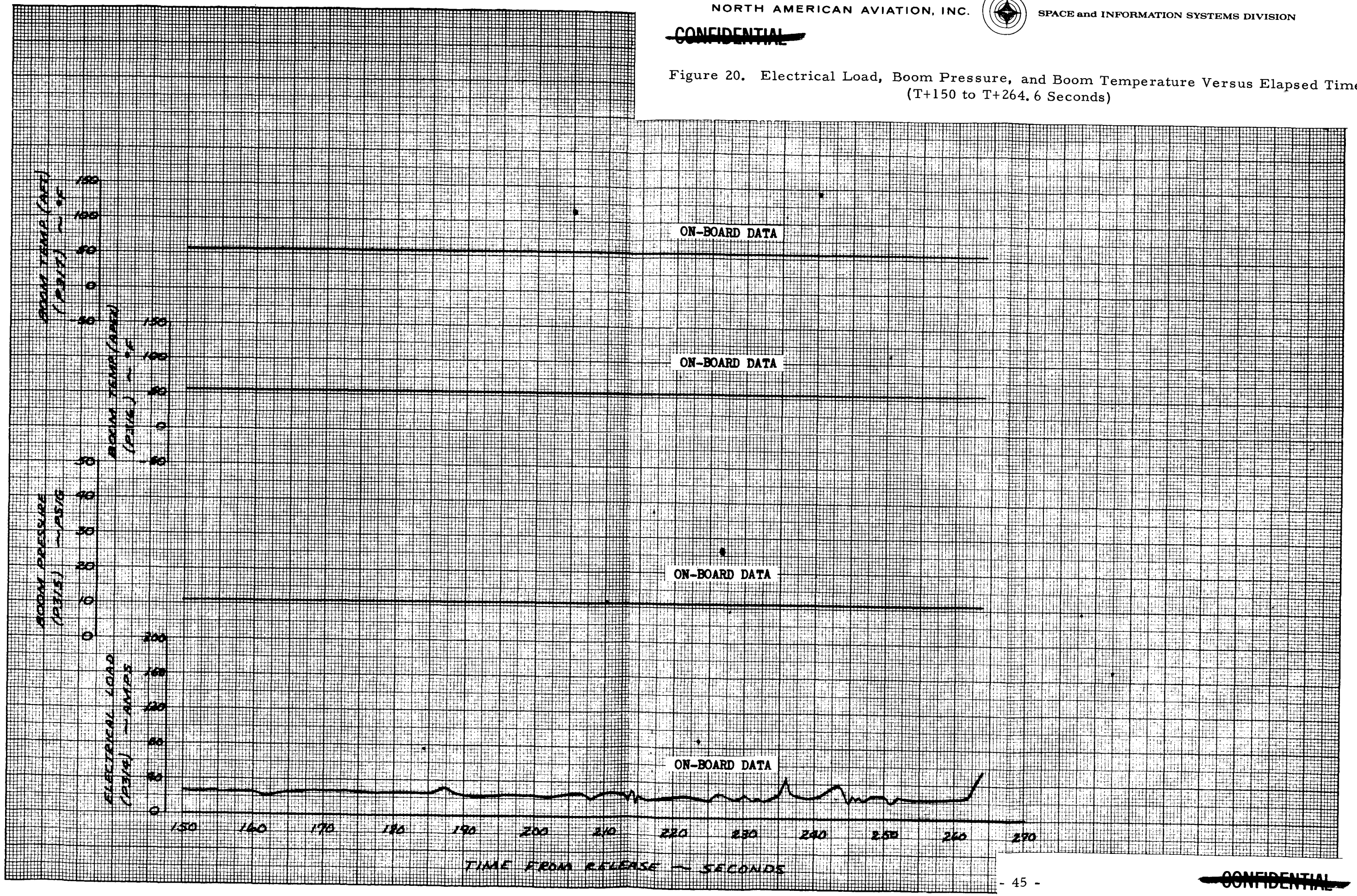
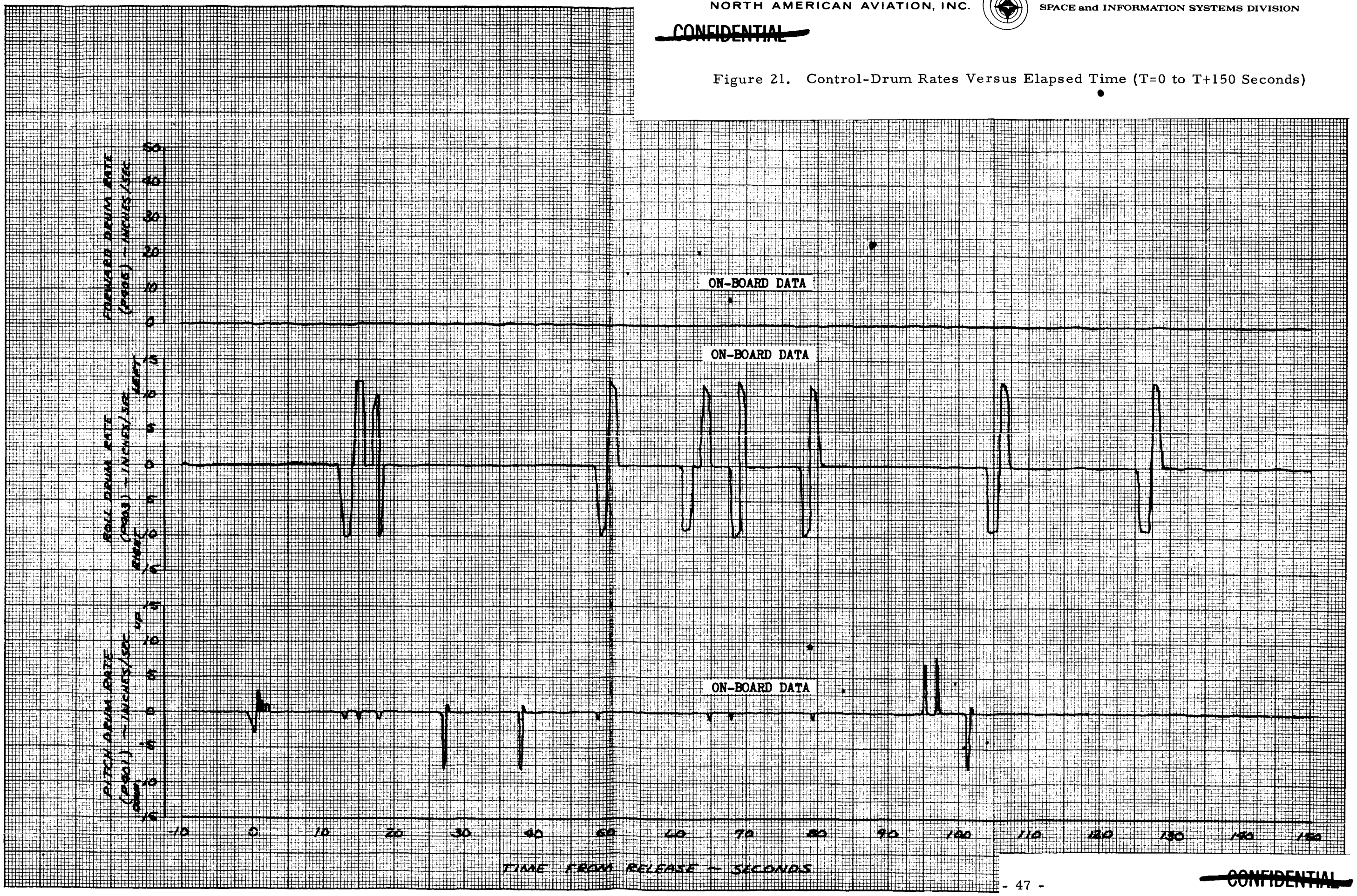
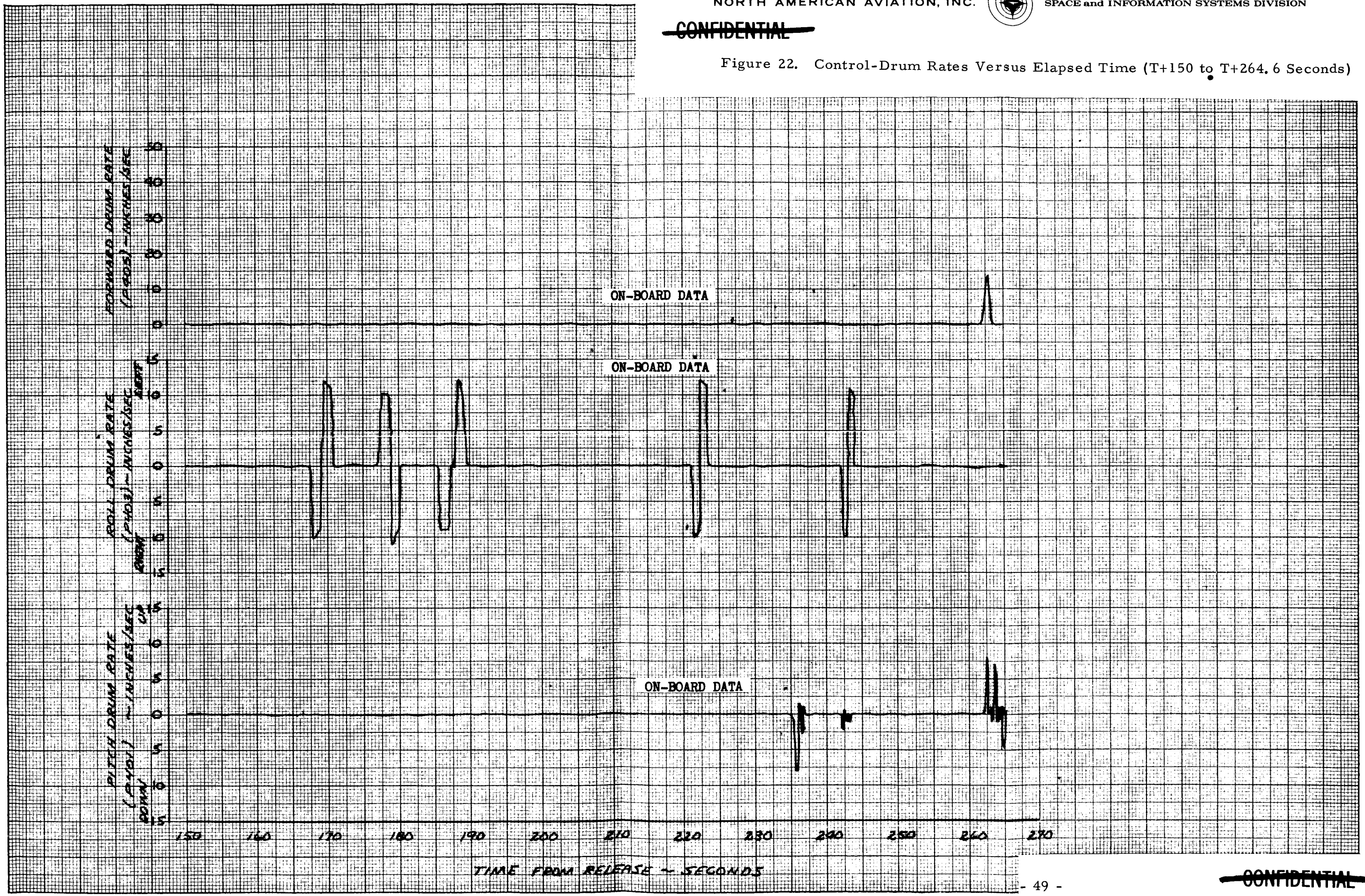


Figure 21. Control-Drum Rates Versus Elapsed Time (T=0 to T+150 Seconds)


FORWARD DRUM RATE (PDDS) - INCHES/SEC
ROLL DRUM RATE (PDDS) - INCHES/SEC
PITCH DRUM RATE (PDDS) - INCHES/SEC
ON-BOARD DATA
ON-BOARD DATA
ON-BOARD DATA
TIME FROM RELEASE - SECONDS

~~CONFIDENTIAL~~

Figure 22. Control-Drum Rates Versus Elapsed Time (T+150 to T+264.6 Seconds)



~~CONFIDENTIAL~~

5.0 EVALUATIONS AND CONCLUSIONS

FLIGHT PERFORMANCE EVALUATION

General

The evaluation of flight performance from the tape data and observed flight characteristics indicated that the pitch and roll control systems functioned properly. A tendency for the vehicle to slowly turn to the left was observed with the roll command in neutral. It is believed this resulted from lateral misalignments (i.e., tolerance of boom-line measurements and boltrope measurements) and/or the effects of winds.

Aerodynamic Performance

An evaluation of the vehicle's aerodynamic performance was made on the basis of radar and Askania data (uncorrected for the effects of winds). These data compared favorably, yielding the vertical and horizontal flight distances of approximately 6,250 feet and 19,200 feet, respectively. Askania data with wind corrections were available and a graphical integration of the horizontal velocity with respect to time yielded a flight range of approximately 14,700 feet. The on-board tape recorder and Askania data agreed on a total flight time of 264.6 seconds.

A review of the flight test data shows a variation of velocities with respect to time which precludes analysis on the basis of steady state conditions. These continued transients throughout the flight profile can be attributed to the repeated control commands necessary for maintaining the desired airborne-controlled flight path. Consequently, the data were evaluated on the basis of averaged measurements and observations.

Taking the Askania data corrected for winds and computing averages yields a sink rate of 23.6 feet per second, a horizontal velocity of 55.5 feet per second and a total velocity of 60.2 feet per second. This compares to predicted averages (trimmed for maximum lift-to-drag ratio of 23.25 feet per second for sink rate, 63 feet per second for the horizontal velocity and 67.25 feet per second for the total velocity. On the basis of comparison, the indication would be that the average trimmed flight condition was at an angle of attack somewhat higher than that at maximum lift-to-drag ratio. The indication of the forward line being approximately nine-inches longer than nominal during glide would account for 5-degree increase in the trimmed angle of attack but not the 9 degrees indicated by the velocity comparisons.

Determination of true velocity is dependent upon the accuracy of the weather data used to correct measured flight test data. The accuracy of weather data is dependent upon the time of measurement, the place of measurement and the quality of measuring devices. When comparing the time and place of weather measurements to that of the actual flight, it is quite possible the wind information used is not exact. The relatively small magnitude of the difference in the average horizontal velocities (7.5 feet per second) could be attributed to discrepancies in wind data.

On a basis of comparison of the averages it is noted that the flight test results show good agreement to the predicted aerodynamic performance. However, to determine more precisely the actual flight performance characteristics, additional test data will be required. These data should be obtained as near as possible to the steady-state glide condition. Also, due to the relatively low gliding velocities of the vehicle, the true velocity is extremely sensitive to winds.

Stability and Control

Pitch

The stability and control characteristics showed satisfactory operation throughout the flight regime. The observed free-flight characteristics, as well as the onboard recorded data, indicated no apparent problem areas. At tow release the onboard data showed a pitch-rate oscillation of approximately 9.4 radians per second which damped in approximately 2.5 seconds. Although the frequency recorded was higher than the predicted short-period pitch frequency, the conditions at tow release can be expected to exhibit frequencies influenced by wing-cable dynamics, i.e., wing motion relative to the capsule. Coupled with elastic characteristics the higher frequencies appeared reasonable. Longitudinal frequencies measured during glide after a pitch command again showed a temporary oscillation near the 9 radians per second level. However, the predominate short period oscillation of approximately 2.5 to 3.0 radians per second can be observed in the recorded data. As a check of short period frequency the following calculation was made:

$q \simeq 4.0$ psf

$l_k = 14.9$ ft

$S_{ref} = 178.5$ ft^2

$I_y = 407.5$ slug-ft^2

$C_{m_\alpha} = -.004$ (Estimate from HSTV Ames Wind Tunnel Test)

$$W_{sp} = \frac{\sqrt{57.3\ q\ S_{l_k}\ C_{m_\alpha}}}{I_y} = \frac{\sqrt{(57.3)(4.0)(178.5)(14.9)(0.004)}}{407.5}$$

$$W_{sp} = 2.45 \text{ rad/sec}$$

The computed short period frequency agrees very well with the recorded data.

Aft line pitch control rates were slightly lower than the design value. Aft line rates of approximately 7.5 inches per second were recorded for the pitch commands (a design value of 9 inches per second was nominal). The lower aft pitch rate did not appreciably effect system performance, however, the 7.5 inches per second rate is considered a minimum value without increasing the flare initiation altitude or reducing flare performance. Forward line payout at flare was recorded at 17 inches per second. The forward payout rate is directly influenced by forward line load. The performance data indicated a lower dynamic pressure during the flight than had been anticipated, however, these data are extremely dependent upon atmospheric information since dynamic pressure was computed from tracking data and wind velocity. A lower dynamic pressure at initiation of the flare mode would, indeed, reduce line loads and yield a lower line payout rate. Investigation of the forward line position appears to indicate an extended length in flare of approximately 113 inches or approximately 4 inches over the design position. The line length error traced back to glide position would indicate approximately a 8.9 inch error at glide. The result of such an error would tend to produce a lower lift-to-drag ratio and also a reduced dynamic pressure. The source of the possible problem is discussed in Flight Control evaluation section of the test report.

Lateral

Lateral response characteristics appear satisfactory and no problem areas are apparent. The measured frequencies, indicative for the dutch roll mode, range from 2.6 to 3.0 radians per second. The computed dutch roll frequency is shown below:

$q = 4.0$ psf

$b = 22.5$ ft

$S_{ref} = 178.5$ ft^2

$I_z = 144.5$ slug ft^2

$C_{n_\beta} = 0.001$ (Estimate from HSTV Ames Wind Tunnel Test)

CONFIDENTIAL

$$W_{DR} = \frac{\sqrt{57.3\ q\ sb\ C_{rp}}}{I_Z} = \frac{\sqrt{(57.3)(4.0)(178.5)(22.5)(0.001)}}{144.5}$$

$$W_{DR} = 2.52 \text{ rad/sec}$$

The above computed frequency shows reasonable correlation with the free flight data.

The tendency for the vehicle to turn left during free flight can be attributed to lateral misalignments and/or wind velocity. The recorded weather data showed the general wind velocity direction to be from the northeast. The flight path was from the northeast to the southwest. Therefore, wind velocities appear to create a tailwind and a lateral wind tending to produce drift to the left. The combination of a left-turn misalignment and a left-wind drift represents a potentially difficult lateral control condition. However, remote control of this situation appeared to be very successful. Observed roll characteristics from film coverage substantiated the lateral maneuvering capability. The capsule appeared to be aligned with the keel plane during turn maneuvers and exhibited adequate damping during the transient period.

The roll-control drum rates indicate, for a right turn, a maximum of 10 inches per second and, for a left turn, a maximum of 12 inches per second. The design criteria was set for 6 inches per second rate limit. Roll line position shows a maximum 12.5-inch line change for a right turn and a maximum 12-inch line change for a left turn. The nominal design value was 11.9 inches. The higher roll drum rates did not appreciably effect the system capabilities and are considered satisfactory for the control system operation. The design rate of 6 inches per second will be utilized on future test operations.

Because the recorded differential loading of the roll cables was low the higher rate does not affect power requirements or capacity.

INSTRUMENTATION SYSTEMS EVALUATION

A total of thirty-five measurements and associated calibration voltages were monitored and recorded by the on-board tape recording system. All systems operated satisfactorily and good data were obtained with the exception of measurement P201 (Normal Acceleration). This measurement was at OVDC throughout the flight.

A post-flight investigation of capsule wiring indicated a short to ground between the normal acceleration input signal pin on the SCO chassis and capsule structure. The SCO chassis was removed and given a thorough

functional test in the laboratory. No electrical discrepancies were found. It is felt that this condition was caused by some foreign matter in the SCO chassis.

The instrumentation systems in the director aircraft and the ground communication van also performed satisfactorily. This system monitors both radio-command signals and the audio between the director aircraft and ground van.

Good photographic data was gathered by the on-board cameras. Since this was a predeployed configuration, Camera No. 2 (deployment) was not installed. Both Camera No. 1 (horizon) and Camera No. 3 (Spreader Bars) operated satisfactorily.

FLIGHT CONTROL SYSTEM EVALUATION

The flight control system responded satisfactorily to all commands during the flight. All commands were given during the flight although the system was never flown in a trim position above glide.

The shroud-line loads were a steady state 160 pounds with a delta load of from 40 to 80 pounds during roll maneuvers. The control line rate was ten inches per second and the line position indicated 12.5 inches of cable travel during the commands. This rate was faster than expected but was due to the light delta load during roll maneuvers.

The aft diagonal-line rate was eight inches per second. Line position change was three inches per step. A minimum of pitch commands were given during the flight and the loads, rates and position data for commands was thus limited. The data indicated the forward control line length to be 86 inches at the glide position. The forward line repositioned to 104 inches at the flare command. The indicated position of the forward line length is questionable when a comparison is made with the combined systems tapes. The last three combined systems tapes were reviewed to obtain line readout information. The glide length was 80 inches of steel cable and the flare length was 99 inches of steel cable. The delta line length during the combined systems testing was recorded as 19 inches and the recorded delta line length during flight was 18 inches. These delta line lengths agree within the accuracy of the recording system and the conclusion is that the glide and flare cam switches were improperly set.

This improper setting was possible if the cams were set originally with the 300-pound weight, and if the 100-pound weight was used during checkout. If such an error were made, the line would have stopped short of the desired length. Resetting the cams to get the proper line length using

the 100-pound weight would have resulted in the wrong line length setting for flight. The line loads during the flight were not great enough to have caused line slippage; therefore, it is concluded that the flare cam was reset with the 100-pound weight and that the glide cam was inadvertently moved during the resetting operation.

The conclusion, therefore, is that the calibration procedure of the forward line should be changed. The actual line length will be measured and recorded and the voltage corresponding to this length will be recorded. The weight will be 300 pounds at all times on the forward line. The calibration of the forward line will be an 11-point calibration with the glide and flare lengths as two of the points. The line will be calibrated for a total length of 130 inches of steel cable.

ELECTRICAL POWER SYSTEMS EVALUATION

The electrical power system operated satisfactorily during the entire flight. There was approximately 30 amperes per minute of power used during the flight. The battery is designed to have a capacity of 127 amperes per minute to insure that the potential remains above 24 volts during expected transient loads; also, the actual transient loads experienced during the flight were much lower than anticipated. The transients were expected to be in the order of 140 to 240 amperes and during this flight the transients appeared to be approximately 40 to 60 amperes.

The nominal battery load was 28 amperes which is consistent with previous ground and flight tests. The batteries were operated for a longer period of time, due to the nature of the predeployed flight, than they will be in a deployment flight. The majority of the power system components have now been tested in flight and no problems seem to be evident.

RADIO COMMAND SYSTEM EVALUATION

The radio command system functioned satisfactorily during the entire flight. All transmitted commands were received properly. No changes to the radio command system are indicated.

6.0 PARAGLIDER PROBLEM STATUS

Flight	Problem	Corrective Action
1. Predeployed Flight No. 1	The electrical connector to the apex release fitting was pulled apart on lift-off.	The connector was safetied and lift-off procedures were revised.
2. Predeployed Flight No. 2	The apex release detent pin was snagged by the electrical cable to the disconnect squibs and mechanically released the fitting prior to the scheduled time.	A shroud was fitted over the detent pin.
3. Predeployed Flight No. 3	1. The apex release fitting prematurely disconnect by mechanical means.	The release fitting was replaced by a positive mechanical fitting with no release capability and the tow line will be cut by a cable cutter.
4.	2. Improper positioning of the stepping switch in the flight control system prior to take-off.	A positive method of monitoring the switch position is being provided.
4. Predeployed Flight No. 4	Pin puller squib failed to fire	Investigation revealed an open fuse in circuit. Fuse was replaced.
5. Predeployed Flight No. 5	1. Capsule tumbled on impact	Landing shoes removed and the forward edge of balsa skid was radiused.
	2. Normal acceleration measurement (#P 201) inoperative.	System checkout following flight and no trouble was evident. It is felt that foreign matter in a connector caused the measurement to be inoperative.

APPENDIX A

Instrumentation Configuration

CHANNEL ASSIGNMENTS			
Channel No.	Meas. No.	Channel No.	Meas. No.
1-1	Intervalometer	2-18	P309
1-2	P202	2-18	P310
1-3	P201	2-19	P311
1-4	P213	2-19	P312
1-5	P212	2-19	P313
2-1	P101	2-20	P314
2-2	P102	2-21	P315
2-3	P103	2-22	P316
2-4	P104	2-23	P317
2-5	P105	2-24	P501
2-6	P106	2-24	P502
2-7	P107	2-24	P508
2-7	P108	2-25	P503
2-8	P109	2-25	P504
2-8	P110	2-25	P509
2-9	P203	2-26	P505
2-10 thru 2-17	All will be grounded	2-26	P506
2-18	P301	2-26	P507
2-18	P302	2-27	Calib. Sig. +5 VDC
2-18	P303	2-28	Calib. Sig. 0 VDC
2-18	P304	3	P211
2-18	P305	4	P401
2-18	P306	5	P403
2-18	P307	6	P405
2-18	P308	7	60 CPS Oscill.

APPENDIX B

Master Instrumentation List

Meas. No.	Measurement	Range	Instrument	Converter	Remarks
P101	Forward Keel Shroud Line Load	0 to 2200 lb ±5%	Primec Tensiometer Model TP-240-SP	None	
P102	Diagonal Keel Shroud Line Load	0 to 2500 lb ±5%	Primec Tensiometer Model TP-240-SP	None	
P103	Aft Keel Shroud Line Load	0 to 800 lb ±5%	Primec Tensiometer Model TP-240-SP	None	
P104	Left Boom Shroud Line Load	0 to 2000 lb ±5%	Primec Tensiometer Model TP-240-SP	None	
P105	Right Boom Shroud Line Load	0 to 2000 lb ±5%	Primec Tensiometer Model TP-240-SP	None	
P106	Forward Keel Shroud Line Length	0 to 121 in. ±2%	F/C Signal	None	
P107	Diagonal Keel Shroud Line Length	±18 in. ±2%	F/C Signal	None	Meas. P107 and P108 are given by the same signal
P108	Aft Keel Shroud Line Length	±18 in. ±2%	F/C Signal	None	Meas. P107 and P108 are given by the same signal
P109	Left Boom Shroud Line Length	±23 in. ±2%	F/C Signal	None	Meas. P109 and P110 are given by the same signal
P110	Right Boom Shroud Line Length	±23 in. ±2%	F/C Signal	None	Meas. P109 and P110 are given by the same signal

Meas. No.	Measurement	Range	Instrument	Converter	Remarks
P201	Normal Acceleration	-3 to +10G ±2%	Humphrey Model LA39-0601-1	None	
P202	Lateral Acceleration	±3G ±2%	Humphrey Model LA39-0601-1	None	
P203	Longitudinal Acceleration	-3 to +10G ±2%	Humphrey Model LA39-0601-1	None	
P204	Normal Acceleration	-1 to +4G ±2%	Humphrey Model LA39-0602-1	None	
P205	Lateral Acceleration	±2G ±2%	Humphrey Model LA39-0602-1	None	
P206	Longitudinal Acceleration	-1 to +4G ±2%	Humphrey Model LA39-0602-1	None	
*P207	Pitot Pressure				
*P208	Static Pressure				
*P209	Angle of Attack (Pitch)				
*P210	Angle of Attack (Yaw)				
P211	Pitch Rate	±500°/Sec ±3%	Humphrey Model RG02-0908-1	None	
P212	Roll Rate	±500°/Sec ±3%	Humphrey Model RG02-0908-1	None	

Meas. No.	Measurement	Range	Instrument	Converter	Remarks
P213	Yaw Rate	±500°/Sec ±3%	Humphrey Model RG02-0908-1	None	
P214	Pitch Rate	±100°/Sec ±3%	Humphrey Model RG02-0909-1	None	
P215	Roll Rate	±100°/Sec ±3%	Humphrey Model RG02-0909-1	None	
P216	Yaw Rate	±100°/Sec ±3%	Humphrey Model RG02-0909-1	None	
*P217	Pitch Attitude				
*P218	Roll Attitude				
*P219	Yaw Attitude				
P301	System Timer Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P302	Camera Switch Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P303	"A" Can Release Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P304	Pressurization Valve Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.

CONFIDENTIAL

Meas. No.	Measurement	Range	Instrument	Converter	Remarks
P305	Partial Pressure Switch Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P306	Full Pressure Switch Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P307	Drogue Chute Release Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P308	Trailing Edge Release Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P309	Apex Disconnect Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P310	F/C Forward Keel Payout Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P301 thru P310 are taken from the same resistance network.
P311	Cable Cutter Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P311, 312, 313 are taken from same resistance network.
P312	Parachute Mortar Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P311, 312, 313 are taken from same resistance network.

CONFIDENTIAL

Meas. No.	Measurement	Range	Instrument	Converter	Remarks
P313	Emergency Chute Release Operation	On-Off Function	28 VDC Signal	Resistance Network	Meas. P311, 312, 313 are taken from same resistance network.
P314	Electrical Load	0 to 100 Amp ±2%	50 Millivolt Shunt	DC Amp	
P315	Internal Boom Pressure (Apex)	0 to 50 PSIG ±2%	Edcliff Model 2-51	None	
P316	Internal Boom Temperature (Apex)	-65 to +120°F ±2%	Glennite Thermistor Model 31TD2	Resistance Bridge, NAA	
P317	Internal Boom Temperature (Aft)	-65 to +120°F ±2%	Glennite Thermistor Model 31TD2	Resistance Bridge, NAA	
P401	Pitch Drum #1 Rate	0 to 23 rad/sec ±2%	F/C Signal	Voltage Divider	
*P402	Pitch Drum #2 Rate			Voltage Divider	
P403	Roll Drum #1 Rate	0 to 16 rad/sec ±2%	F/C Signal	Voltage Divider	
*P404	Roll Drum #2 Rate			Voltage Divider	
P405	Forward Drum Rate	0 to 32 rad/sec ±2%	F/C Signal	Voltage Divider	

Meas. No.	Measurement	Range	Instrument	Converter	Remarks
P501	R/C Turn Left	On-Off Function	28 VDC Signal	Resistance Network	Meas. P501, 502, 508 are taken from the same resistance network
P502	R/C Turn Right	On-Off Function	28 VDC Signal	Resistance Network	Meas. P501, 502, 508 are taken from the same resistance network
P503	R/C Pitch Up	On-Off Function	28 VDC Signal	Resistance Network	Meas. P503, 504, 509 are taken from the same resistance network
P504	R/C Pitch Down	On-Off Function	28 VDC Signal	Resistance Network	Meas. P503, 504, 509 are taken from the same resistance network
P505	R/C Flare	On-Off Function	28 VDC Signal	Resistance Network	Meas. P505, 506, 507 are taken from the same resistance network
P506	R/C Emergency Chute	On-Off Function	28 VDC Signal	Resistance Network	Meas. P505, 506, 507 are taken from the same resistance network
P507	R/C Jettison Wing	On-Off Function	28 VDC Signal	Resistance Network	Meas. P505, 506, 507 are taken from the same resistance network
P508	R/C F/C Pin Release	On-Off Function	28 VDC Signal	Resistance Network	Meas. P501, 502, 508 are taken from the same resistance network

Meas. No.	Measurement	Range	Instrument	Converter	Remarks
P509	R/C Camera #1	On-Off Function	28 VDC Signal	Resistance Network	Meas. P503, 504, 509 are taken from the same resistance network

*Indicates measurement to be taken on full scale model only.